Engineering Standard

Track

OTCS 220

RAIL AND RAIL JOINTS

Version 1.0

Issued August 2018

Approved by:

Document control

Revision	Date of Approval	Summary of change
1.0	August, 2011	First Issue. Includes content from the following former RIC standards: C 2405, C 2447, C 2501, C 3200, C 3201, C 3361, C 5200, TS 3101, TS 3104, TS 3111, TS 3341, TS 3362, TS 3371, TS 3394, TS 3396, TS 3397, TS 3601, TS 3602, TS 3603, TS 3604, TS 3606, TS 3642, TS 3645, TS 3646, TS 3648, TS 3650, TS 3654, TS 3655, RC.2410, RC.2411, RTS.3602, RTS.3640, RTS.3733, RCSI.019, CTN 01/14, CTN 03/04 and CRN CS 220 Ver 1.2

Summary of changes from previous version

Section	Summary of change

Contents

1 Scope and application

This Standard establishes design requirements, approved configurations, acceptance standards, damage limits and repair standards for rail, rail joints, rail welds, rail lubrication, rail anchors and rail adjustment.

It is applicable to all main line and siding tracks.

1.1 Methods of measurement

All measurements and testing requirements in this standard shall be undertaken using the methods documented in Engineering Manuals CRN CM 203 “Track Inspection” and CRN CM 224 “Rail Testing and Defects”

2 References

2.1 Australian and International Standards

AS 1085.1 (2002) Railway Track Material Part 1: Steel rails

AS 1085.1 (1980) Railway Track Material Part 1: Steel rails

AS 1085.2 (2002) Railway Track Material Part 2: Fish plates

AS 1085.4 (2002) Railway Track Material Part 4: Fish bolts and nuts

AS 1085.7 (2003) Railway Track Material Part 7: Spring washers

AS 1085.10 (2002) Railway Track Material Part 10: Anchors

AS 1085.12 (2002) Railway Track Material Part 12: Insulated joint assemblies

AS 1085.15 (1995) Railway Permanent Way Material Part 15: Aluminothermic rail welding

AS 1085.18 (2003) Railway Track Material Part 18: Screw spikes and threaded inserts

AS 1085.19 (2003) Railway Track Material Part 19: Resilient fastening assemblies

AS 1085.20 (2006) - Welding of steel rail

AS 2382 (1981) Surface Roughness Comparison Specimens

2.2 OTHR documents

OTCS 200 - Track System

OTCS 230 – Sleepers and Track Support

2.3 Other references

CRN CM 203 - Track Inspection

CRN CM 221 – Rail Installation and Repair

CRN CM 222 – Rail Welding

CRN CM 223 – Rail Adjusting

CRN CM 224 - Rail Testing and Defects
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3 Engineering authority

Design and selection of infrastructure detailed in this standard for use on the OTHR may only be undertaken by persons who have been granted appropriate Engineering Authority by the Engineering Manager.

4 Design & performance criteria

To be determined

5 Allowable configurations

5.1 Rail

5.1.1 New rail

New rail shall comply with the following criteria:

- All new 50 kg and 60 kg rail shall be manufactured to Australian Standard AS 1085.1 (2002).
- 47 kg and 53 kg rail cross section shall comply with AS 1085.1(1980). All other properties shall comply with AS 1085.1 (2002)
- Rail ends shall be undrilled

Note: 60 UIC rail section does not meet the requirements of AS 1085.1 (2002) and is not approved for use.

The dimensions and properties of other, older, rail sizes in use are documented for reference in Engineering Manual CRN CM 221 “Rail Installation and Repair”.

5.1.1.1 Rail size

Rail size shall be selected in accordance with the track class detailed in OTCS 200. Approved alternative rail sizes for each track class are detailed in Table 1. Selection of a different rail size may impose requirements for rail welding, sleeper type, ballast depth or fastening type. These requirements are detailed in the track element standards referenced in OTCS 200.

Track Class	Rail Size (kg/m)	
	Preferred	Approved Alternatives
Main Line		
1	60	53, 60H
2	50	47, 53
3	41	40, 47
3G	53	
5	30	40, 41,
Sidings		
1	60	53, 50
2	50	47, 53
3	41	40, 47

Table 1 – Selection of Rail size

5.1.1.2 Use of head hardened rail

Head hardened 60kg/m rail (60H) shall be selected for use in accordance with the existing or proposed track structure class detailed in standard OTCS 200 and the following requirements.

- On any line where axle loads heavier than 25tonne are to operate at levels > 1 MGT per year
- At other locations selection of head hardened rail will depend on the operational requirements, site conditions and the rail management strategy adopted. Consideration shall be given to the use of head hardened rail on track meeting the annual tonnage and curvature requirements in Table 2.

Tonnage (MGT per yr)	Curvature			
	Sharp (<301m)	Moderate (301-699m)	Flat (700-1500m)	Very Flat (>1500m)
less than 10	60H	60	60	60
10 to 14	60H	60H	60	60
15 to 19	60H	60H	60H	60
20 or greater	60H	60H	60H	60H

Table 2 – Selection of Head Hardened Rail

In addition consideration shall be given to the use of 60H rail in the following locations:

- Sections of track with excessive rail wear rates
- Curves with 6 yearly renewal cycles or less for standard carbon rail
- Platform and approach tracks with similar renewal cycles caused by heavy train braking
- Grades 1 in 40 or steeper subject to extensive train braking or skidding
- In Turnout Renewals.(for Class 1 mainline track)

5.1.1.3 Installation requirements

1. Drilling of holes in rails should be minimised.
2. Rail shall be installed on plain track with a cant of 1 in 20 towards the centreline of the track.
3. The rail shall be welded into lengths required by the track class using approved welding processes. (See Appendix 2).
4. The minimum rail length to be installed on welded track 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.
5. The up and down rail of track shall be the same equivalent rail size.
6. Head hardened rail may be mixed with standard carbon rail on opposing rails.
7. 60kg/m rail shall be fastened only with resilient fastenings.
8. When replacing 53 kg/m with 60 kg/m rail, allowance shall be made for the 13mm increase in rail height. The effects of the increased height of the 60kg/m rail must be checked in such aspects as the setting of tamping tools and structure clearances.

5.1.2 Recycled rail

Recycled rail may be selected for use in existing mainline tracks and new or existing sidings in accordance with the requirements detailed in Table 3 below, and subject to the restrictions also detailed below. The recycled rail categories are explained in Table 4.

Track Class	Recycled rail sections allowed (kg/m)		
	Category 1 (White Rail)	Category 2 (Blue Rail)	Category 3 (Red Rail)
Main line			
1	53[(1), (2), (3), (4)], 60	53[(1), (2), (3), (4)], 60	Not permitted
2	47 [(3)], 50, 53[(3)], 60	50, 53[(3)], 60	Not permitted
3	40, 47	47	Not permitted
3G	53	53[(3)]	TBD
5	30, 40, 41	TBD	TBD
Sidings			
1	53 [(3)], 60	53 [(3)], 60	Not permitted
2	47 [(3)], 50, 53[(3)], 60	50, 53[(3)], 60	Not permitted
3	41, 40, 47	40, 47	TBD

Table 3 - Use of Recycled Rail by Track Class

Note- 1. 53kg/m rail which is recycled for use on Class 1 main lines may be used only on lines operating with < 5 MGT per year and which have ≤ 1 MGT per year of 25 tonne axle load freight traffic.

2. on Class 1 main lines operating ≥ 5 MGT per year and > 1 MGT per year of 25 tonne axle load freight traffic, recovered 53kg/m rail may only be used for the repair of rail defects and conversion to CWR to match worn rails on existing 53kg/m track.
3. Or equivalent rail class (see Table 5).
4. Recycled “French" rail (Longwy and Micheville brands) shall not be used on main line tracks. It is suitable for installation in crossing loops where 25kph is not exceeded and in sidings.
5. Category 4 rail is painted GREEN and is not approved for use in track

Recycled rails used for rerailing shall meet the following requirements

- Rail wear shall meet the classification limits given in Table 4.
- Rails shall be visually inspected and have
  - No visible web fillet cracks
  - No head or foot cracks
  - No crush or laminated head
- Rails that cannot be checked for cracks because of grease or from tunnels shall be ultrasonically tested before paintcoding.
- Rails that are intended for transposing shall be ultrasonically tested. All defects shall be removed.
- Any unground welds on field side head of rails that are intended for transposing shall be ground to create the new gauge face.
- Wheel burns more than 3mm deep shall be removed or corrected
- Visible end batter shall be removed or corrected if rail is to classified for reuse in mainlines
- Rail shall not have excessive rust
- Rails with more than 6 aluminothermic welds in a 100m length shall be ultrasonically tested. All defects shall be removed

- The gauge face shall be re-profiled to the correct rail profile by removing any lip that has developed
- The 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 1).

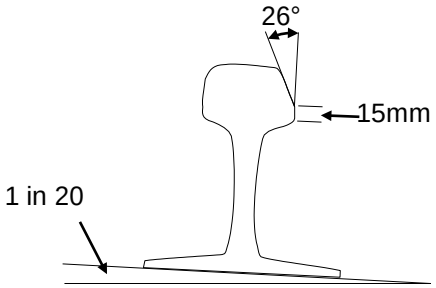


Figure 1 – Gauge Face Angle

- 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 2).

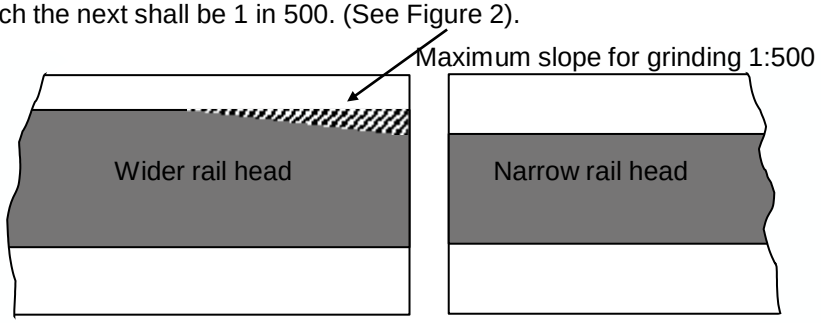


Figure 2 – Maximum slope for grinding

Rail Section Kg/m	Original dimensions		Category 1 (White Rail)		Category 2 (Blue Rail)		Category 3 (Red Rail)		Category 4 (Green Rail)	
	Width mm	Depth mm	Width mm	Depth mm	Width mm	Depth mm	Width mm	Depth mm	Width mm	Depth mm
60 Kg/m	70	44	≥ 66.5	≥ 35	≥ 63.5	≥ 35	> 46	> 26	≤ 46	≤ 26
53 Kg/m *	70	40	≥ 66.5	≥ 35	≥ 63.5	≥ 35	> 46	> 22	≤ 46	≤ 22
50 kg/m	70	40	≥ 66.5	≥ 35	≥ 63.5	≥ 35	> 47	> 22	≤ 47	≤ 22
47 Kg/m *	70	37	≥ 66.5	≥ 33	≥ 63.5	≥ 33	> 46	> 24	≤ 46	≤ 24
41 Kg/m *	63	35	≥ 60	≥ 30	≥ 5	≥ 30	> 41	> 23	≤ 41	≤ 23
80 lb/ yard AS (1937) “B” (new)	64		≥ 60	≥ 30	≥ 57	≥ 30	> 41	> 23	≤ 41	≤ 23
80 lb/ yard AS (1928) “A” (old)	70		≥ 66.5	≥ 27	≥ 63.5	≥ 30	> 46	> 23	≤ 46	≤ 23
80 lb/ yard AS (1916) (old)	70		≥ 66.5	≥ 27	≥ 63.5	≥ 30	> 46	> 23	≤ 46	≤ 23
80 lb/ yard AA (1907)	64		≥ 60	≥ 30	≥ 57	≥ 35	> 41	> 23	≤ 41	≤ 23

Table 4 – Rail Categories by Wear Limit

** Includes equivalent Classifications (see Table 5)*

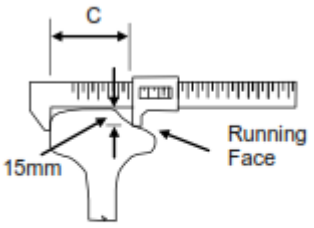
Size	Equivalent				
60 kg/m	Not applicable				
53 kg/m	107 AS 1936	103 AS 1936	100 AS 1928		
47 kg/m	94 AS 1937	90 AS 1928	90 AS 1925	90 AS 1916	90J 1913
41kg/m	80 AS “B” 1928 (80 NEW)	80 AS “A” 1928 (80 OLD)	80 AS 1916 (80 OLD)		
35	70 AS 1928	70 AS 1925	70 AS 1916	70 1910	
31	60 ASB 1928	60 ASA 1928, 60 AS 1916	60 BA 1907	60 B 1896	60 B 1896

Table 5 – Equivalent Rail Sizes

5.1.3 Transposed rails

Rails subject to curve wear may be transposed and reused in tangent track, subject to curve wear not exceeding the limits detailed in Table 6 prior to re-use.

Rail Size	Rail Section	Minimum Head Width “C”
60	60 AS 1977 1981	49
53	53 AS 1977 1981	49
53	107 AS 1936 1964	49
51	103 AS 1936	49
50	50 AS 1977 1981	50
50	100 AS 1928	52
50	100 AS 1916	58
50	100 C 1907	51
50	100 C 1901	52
47	94 AS 1937	49
45	90 AS 1928, 90 AS 1925	52
45	90 AS 1916	56
45	90 J 1913	52
41	80 ASB 1928	49
41	80 ASA 1928, 80 A 1916	56
41	80 AA 1906	48
41	80 A 1900	51
41	80 A(1) 1897	50
41	80 A(2) 1895	49
41	80 A(3) 1890	49
39	78 H 1903	55



Measurement of Curve Wear “C”

Rail Size	Rail Section	Minimum Head Width “C”
37	75 BHP 1917	48
36	71 2 D 1875	46
35	70 AS 1928, 70 AS 1925	52
35	70 AS 1916	48
35	70lb 1910	48
31	60 ASB 1928	Not Permitted
31	60 ASA 1928, 60 AS 1916	Not Permitted
31	60 BA 1907	Not Permitted
31	60 B 1896	Not Permitted
31	60 B 1890	Not Permitted

Table 6 - Rail Wear Limits for transposing

5.2 Rail welds

5.2.1 Flashbutt welds

Flashbutt welding processes shall meet the following requirements:

- Long welded rail strings shall be supplied in accordance with the requirements of AS 1085.20 - Welding of steel rail. Type and proof testing shall be carried out using the method and frequency defined in AS 1085.20.
- Storage, transport and delivery of welded rail strings shall be in accordance with AS 1085.20.
- Approved suppliers of long welded rail strings are detailed in Appendix 1.

5.2.1.1 Rails approved for flashbutt welding

Rails approved for flashbutt welding are detailed in Table 7:

For the rail sizes nominated in Table 7, rail manufactured to Australian standards published since the editions listed are also approved for welding.

All other rail sections shall not be welded because of age, wear or suspect chemical composition.

Only rails of the same weight and hardness may be welded by flashbutt welding into welded rail strings.

The minimum distance between flashbutt welds shall be 5m.

5.2.2 Aluminothermic welds

Aluminothermic welding processes and materials shall meet the following requirements:

- Aluminothermic weld materials shall be supplied in accordance with the requirements of AS 1085.20. Type and proof testing shall be carried out using the method and frequency defined in AS 1085.20.
- Transport and storage of weld consumables shall be in accordance with AS 1085.20.
- Aluminothermic welding may only be undertaken using approved aluminothermic welds, Approved aluminothermic welds including standard, wide gap and junction welds are detailed in Appendix 2.
- Aluminothermic welding may only be undertaken by persons with competencies documented in BCM 222, using approved aluminothermic welding processes. Approved aluminothermic welding processes are detailed in Appendix 2.

5.2.2.1 Rails approved for aluminothermic welding

Rails approved for aluminothermic welding are detailed in Table 7.

For the rail sizes nominated in Table 7, rail manufactured to Australian standards published since the editions listed are also approved for welding.

Rails of each specified size may be welded to each other. Rails in each of the groups specified in Table 7 may be welded together (e.g. 53 kg A.S. 1981 with 103 lb A.S. 1936). Some rails, although they are treated as being of equivalent rail size as others, may not be welded to rails of other groups (e.g. 90 lb A.S. 1928 with 90J 1913). This occurs because of differences in original rail dimensions greater than the tolerances permitted for welding in Section 5.2.2.2.

Rail Section	Equivalent	Welding Group
60 kg A.S. 1981		WG 1
60 kg A.S. 1981 Head Hardened		
53 kg A.S. 1981	All treated as 53 kg rail See notes below regarding welding of 'French' rail	WG 2
107 lb A.S. 1936		
103 lb A.S. 1936		
100 lb A.S. 1928		
47 kg A.S. 1921	All treated as 47 kg rail	WG 3
94 lb A.S. 1937		
90 lb A.S. 1928		
90 lb A.S. 1925		
90 lb A.S. 1916	All treated as 47 kg rail	WG 4
90J 1913		
41kg A.S. 1977	All treated as 41kg rail	WG 5
80 lb A.S. “B” 1928 (commonly called 80 NEW)		
80 lb A.S. “A” 1928	All treated as 41kg rail	WG 6
80 lb A.S. 1916 (Both commonly called 80 OLD)		
80AA (1907)	Treated as 41kg rail	WG 7

Table 7 - Rails approved for aluminothermic and flashbutt welding, and as junction rails

All other rail sections shall not be welded because of age, wear or suspect chemical composition.

Rails of dissimilar section may be welded together using approved junction welds only for the following sections:

- 60kg to 53kg
- 53kg to 47kg
- 47kg to 41kg
- 30kg to 41kg (Conditions apply - detailed in BCM 222)

Welding of 'French' rails

Because of a high percentage of internal failures in 'French' rails (Longwy and Micheville), particularly vertical split webs, they are NOT to be welded into CWR lengths in main lines.

Field welding of these French rails may be carried out in crossing loops and sidings, provided that ultrasonic testing is carried out and proves the rail satisfactory for welding.

Ultrasonic testing shall include the side of the rail web for a distance of one (1) metre in the vicinity of the proposed weld.

5.2.2.2 Placement and installation requirements

The following placement and installation requirements apply to aluminothermic welds:

General

1. Welds SHALL NOT be installed when exposed to moisture (rain, fog etc.).
2. Rail ends should not be located within 1.2 m of the centre of a bonded insulated joint
3. Aluminothermic welds shall not be placed within 2.2 metres of any weld (flashbutt or aluminothermic) or mechanical (or glued) joint on plain track (main line or siding) except as indicated below

   In turnouts, aluminothermic welds may be placed to within 1.2 metres of a flashbutt weld, aluminothermic weld or mechanical rail joint, provided that -

   ~ The existing 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 the gauge side of each weld is ground prior to passage of trains.
5. Aluminothermic welds are not permitted on a sleeper.
6. Aluminothermic welds shall not sit directly on slab track
7. Aluminothermic welds should not be located within 4m of the approach end of a transom top bridge, nor within 8m of the departure end.
8. Aluminothermic welds should not be located between sleepers of different types
9. Aluminothermic welds should not be located in areas adjacent to slab track and level crossings with rigid surfaces.

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 more than 12 hours (4 hours for Head Hardened rail) shall be re-cut immediately prior to welding, removing a minimum of 25mm.
3. The closure shall conform to existing rail with a maximum 5mm mismatch in height (unless the rail is being welded using an approved junction weld in which case appropriate limits apply) and 5 mm in gauge wear.
4. 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 2).
5. For curves of 500m radius and under, the last 600mm of each end of closures of less than 6m in length and the last 600mm of each rail end shall be crowed to the correct curvature.

Welding near bolt holes

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

2. Bolt holes that are being, or have been, used in track to form a mechanical joint shall be closely examined and if there is any damage, no matter how slight, then all the bolt holes shall be removed. If there is no damage then they may be treated as if they were unused.
3. Bolt holes 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 bolt hole 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 bolt hole. The distance from the edge of the bolt hole to the end of the rail before welding shall be ≥ 80mm.

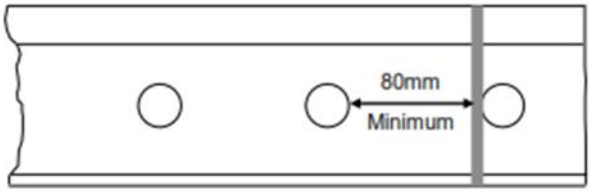


Figure 3 – Minimum distance of bolt hole from weld

Welding near signal bonding holes

Aluminothermic welds shall 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.

5.3 Junction rails

Junction rails shall only be used as closures and must be fully welded into the track.

Rails approved for use as junction rails are detailed in Table 7.

Approved configurations are detailed in Appendix 1.

5.4 Rail joints

5.4.1 Mechanical joints

Rail joint design shall be in accordance with standard fishplated joints detailed in AS 1085.2 (2002), or be equal to or exceed the performance of current proven designs.

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

5.4.1.1 Placement and installation requirements

The following placement and installation requirements apply:

- Joints shall be installed suspended between adjacent sleepers.
- Joints in Long Welded Rail (LWR) shall be no closer to each other than 10m except in turnouts where shorter lengths (minimum 2.2m) may be used if necessary
- Joints are not permitted in continuously welded track
- Joints are not recommended within turnouts in CWR 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 LWR track 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 Section 5.8.
- Permanent Joints shall be fastened through all bolt holes, except for temporary rail joints. (See Section 5.4.2 for temporary joints).

  In existing Class 5 lines where 4 hole fishplates are used, the fishplates shall be fastened through all 4 bolt holes.
- Rail ends shall be saw cut to the following tolerances.
  - Vertical - ≤ 0.7mm variation in the height of the rail
  - Horizontal - ≤ 0.7mm variation in the width of the rail
- Bolt holes 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 defined in AS 1085.2 and AS 1085.12.

Note: The size and location of bolt holes in rail sizes not documented in the current versions of Australian Standards are detailed in BCM 221.

5.4.1.2 Prohibited configurations

The following configurations are specifically prohibited:-

- Joints in 60kg rail except in temporary joints (see Section 5.4.2).
- Joints on concrete sleepered track except in temporary joints (see Section 5.4.2).
- 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 5.4.2).
- Rails with flame cut bolt holes, except in temporary or emergency rail joints (see Section 5.4.2).

5.4.2 Temporary joints

Temporary joints are not permitted to remain in the track for any extended period. Special conditions apply whilst they remain in track. Temporary joints may be used 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.

5.4.2.1 Temporary joints during 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 bolt hole on each rail nearest each rail end shall not be drilled. The joint will be fastened through the remaining 4 bolt holes. To limit damage to the rail and to the track, these temporary joints shall not remain in track longer than 7 days if installed on concrete sleepers, or 12 months if installed on timber or steel 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 are to be removed as soon as the rail can be adjusted correctly. This will preferably occur on the same day that the rail is laid.

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

5.4.2.2 Temporary joints for emergency use

Use of flame cut rail ends

Running rails with flame cut ends are only permitted in extreme emergencies such as temporary track repairs following a derailment.

A speed restriction of 20kph shall be placed on the section until the flame cut rail end is removed.

This does not restrict the use of flame cut rail ends for aluminothermic welding carried out in accordance with approved practices.

Emergency use of flame cut bolt holes

Flame cut bolt holes may be used in an emergency to effect temporary repairs. A speed restriction of 10kph shall be placed on the section and the track continuously monitored until the flame cut bolt hole is removed.

Non-bolted joints

Approved rail clamps may be used to clamp fishplates to create a temporary joint at a broken rail. Conditions apply to their use. Approved plates and clamps are detailed in Appendix 1 and approved configurations are detailed in Table 8.

Clamps	Plating	Conditions of use
G Clamps (2 required)	Standard Fishplates Bow plates	Maximum Speed of 30kph .
Robel" Clamps (1 or 2 required)	Standard Fishplates Bow plates	Maximum Speed of 60kph

Table 8 - Approved non-bolted joints

Robel rail clamps may be used on 41, 47, 53 and 60kg rail in place of G-clamps for plating broken rails and at other locations where G-clamps are normally used.

1. They shall be installed in accordance with the manufacturer's instructions
2. The clamp shall be mounted directly at the rail joint by using two fishplates.
3. Bow plates may be clamped with two (2) Robel rail clamps (one on each side of the bow)

5.4.3 Insulated rail joints

Rail joint design shall be in accordance with standard insulated joints detailed in AS 1085.12, or be equal to or exceed the performance of current proven designs.

Approved insulated joint configurations, including proprietary designs are defined in Appendix 1. Only approved configurations shall be installed.

Insulated joint configurations include:

- standard mechanical insulated joints
- insulated plate joints

- bonded insulated joints

The following placement and installation requirements apply:

5.4.3.1 General

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. Bonded insulated joints should not be installed on transom top bridges or within 30m of the bridge ends.
5. Bonded insulated joints should not be installed at the interface of concrete/ steel/ timber track, or locations where additional track disturbance is likely
6. Where 53kg and 60kg insulated joints are to be installed with resilient fastenings, low profile clips shall be used to avoid fouling the bolts.
7. When used with some baseplates in turnouts with timber bearers, low profile clips may still become foul of the joint bolts. Where this is the case the offending clips shall 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 4).

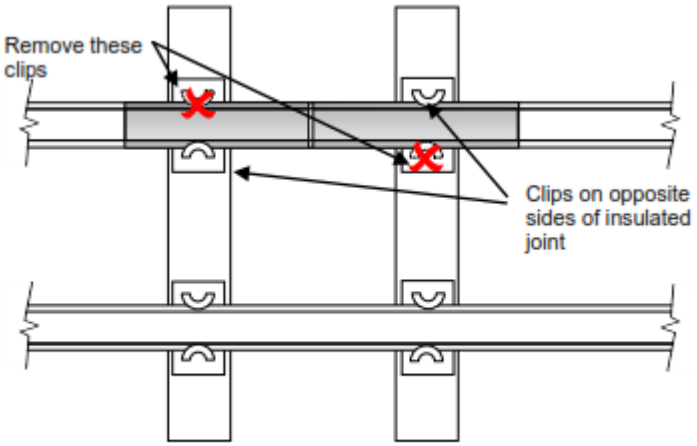


Figure 4 – Placement of clips at insulated joints

5.4.3.2 Mechanical insulated joints

1. are not recommended for mainline track,
2. shall be anchored in accordance with Section 5.8,
3. shall be fastened through six bolt holes,
4. rail ends must be square.

5.4.3.3 Insulated plate joints

(This is the generic term used to describe joints such as Benkler and Hercules)

1. may only be used in the turnout rails within turnout systems on all operating classes. (This excludes any direct connection with CWR plain track),
2. shall be fastened through six bolt holes,

3. shall be anchored as for mechanical insulated joints,
4. curved track sections with insulated joints shall be formed in the field from straight fishplate pieces,
5. rail ends must be square

When selecting the appropriate type of approved Insulated plate joint, the following issues need to be considered;

- "Benkler Joints" are robust joints with good insulation performance but are significantly weaker than bonded insulated joints.
- "Hercules Joints - NIJ 600 series" are a stronger joint but have greater potential for insulation failure. Care is needed to ensure that fastenings do not cause signal failure. Some fastenings may have to be omitted.

5.4.3.4 Bonded insulated joints

1. Factory assembled bonded insulated joints are permitted on all Class 1 and Class 2 tracks.
2. All new bonded insulated joints shall be Grade A1 factory assembled bonded insulated joint assemblies in accordance with AS 1085.12 (2002) using 6 hole joint bars. Rail ends at the insulating post will be cut at 15° to the right angle of the longitudinal axis (see Figure 5).

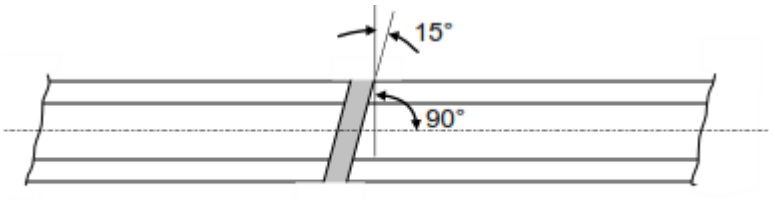


Figure 5 – Rail end angle

3. Head Hardened rail shall be used to form bonded insulated joints (except 47kg where HH is not available).
4. Bonded insulated joints (BIJ) shall be pre-curved to suit the radius of the track in accordance with Table 9.

3.43m Bonded Insulated Joints		
Curve Radius	**Measured Full Mid-ordinate of Track**	**Versine to be Used**
196 - 326 m	7.5 - 4.5 mm	6
326 - 980 m	4.5 - 1.5 mm	3
980 - straight	1.5 - 0 mm	0
4.57m Bonded Insulated Joints		
Curve radius	**Measured full Mid-ordinate of Track**	**Versine to be Used**
217 - 326 m	12.0 - 8.0 mm	10
326 - 1305 m	8.0 - 2.0 mm	5
1305 - straight	2.0 - 0 mm	0

Table 9 - BIJ configurations

5. In existing bonded insulated joints, rail ends may be square or have a 15° cut to the right angle of the longitudinal axis (see Figure 5).
6. BIJs manufactured with HH rail may be installed in non head hardened rail track

5.4.3.5 Prohibited configurations

- Mechanical insulated joints are not permitted in CWR track.
- Insulated plate joints are not permitted in main line CWR track.
- Field assembled bonded insulated joints are not approved for use.
- Mechanical insulated joints and Insulated plate joints are not permitted on bridges and restrictions apply to installation in proximity to bridge approaches.
- Mechanical insulated joints and Insulated plate joints are not permitted within 5m of the transition between different sleeper types

5.4.4 Fishbolts, washers and nuts

Fishbolts and nuts used in conjunction with fishplates in mechanical joints shall be supplied in accordance with AS 1085.4 (2002). The length and diameter of standard fishbolts varies according to the rail sections in which they are being used, as detailed in Table 10.

Special fishbolts detailed in Table 11 shall be supplied in accordance with AS 1085.4 (2002) with a modified neck shape.

Type 1 Spring Washers shall be supplied in accordance with AS 1085.7 (2003). The nominal size shall be the associated bolt diameter.

Rail section		Fishbolt	
Metric	**Imperial coding**	**Length**	**Diameter**
60		140	24
50 - 53	100 AS 28. 100 AS 25, 103 AS 36	140	24
53 AS 78	107 AS 36	140	24
45 - 40	90 AS 28, 90 AS 25, 80 AS ‘B’ 28	140	24
47 AS 78	80 AS 25, 94 AS 37	140	24
45 - 50	100 AS 21, 100 AS 16, 100CA 100C 90 AS 21, 90 AS 16, 90J	140	24
30 - 40	80 AS 21, 80Aa 80A 78H 70 AS 28 60 AS ‘B’ 28	115	22
30 - 40	80 AS 16 80A 60 AS 25	115	22
30	60 AS 16, 60Ba 60B	115	22
30	60 AS 21 (No Washer)	115	22

Table 10 - Fishbolt sizes

Rail section		Fishbolts			
Metric	**Imperial coding**	**Length**	**Diameter**	**Shape of neck**	**Dimension ‘A’**
34 - 40	80A2 80A3 71.5D 80E 75F Deep plate 75F Sharp plate - no washer	100	22	Eye	32
37	75 BHP	110	22	Pear	30
40	80E	100	22	22mm round	-
30	60B’	85	20	Eye	28
30	60B’	85	20	Eye	28

Table 11 - Special fishbolts

The shape of the neck of special fishbolts shall be as shown in Figure 6:

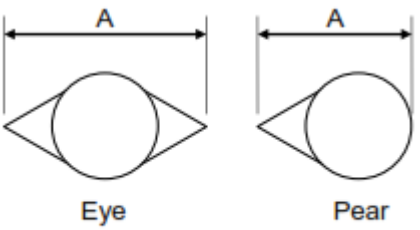


Figure 6 – Special Fishbolt shapes

5.4.5 Swage fasteners

Swage fasteners may be used in lieu of conventional fishbolts at fixed mechanical rail joints

Swage fasteners are suitable for operating conditions with designed axle loads ≤ 25 tonnes at speeds ≤ 120 kph.

Only approved configurations (as documented in Appendix 1) may be used.

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

The following placement and installation requirements apply:

1. Swage fasteners may only be applied to joints designed for no rail movement.
2. their use is restricted to 47, 50, 53 and 60kg/m rail trackwork
3. Swage fastened mechanical joints may be used within turnouts and diamonds and between adjacent turnouts and diamonds but they shall not be used directly adjacent to CWR plain track
4. The application of the swage fasteners shall be restricted to trackwork in good condition, where the contacting surfaces and components of the joint can support the high clamping forces involved.
5. 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 swage fasteners over a larger area. The hole diameter of the washer under collar must not be larger than 1.5mm in diameter more than the shaft size of the swage fastener.

Prohibited configurations

- Swage fasteners shall not be used in open track in lieu of welding.
- Swage fasteners shall 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.

5.5 Rail repair

5.5.1 Wirefeed welding

Wirefeed welding processes may be used to:

- build up fabricated and welded crossings manufactured from standard carbon and head hardened rail
- repair rail bound manganese and titan crossings

- repair wheel burns, Small TD/EBF, dipped aluminothermic and flash butt welds in standard carbon rail
- repair wheel burns, Small TD/EBF, dipped aluminothermic and flash butt welds in head hardened rail where axle loads DO NOT exceed 27 tonnes.

Wire feed welding processes are **NOT** approved for

- repair of wheel burns in head hardened rail where axle loads exceed 27 tonnes.
- repairs to switches in turnouts and other special trackwork. This includes the area from the switch tip to the heel (inclusive).
- repair of rail defects more than 12mm below the top of the rail.

5.5.2 Aluminothermic rail head repair

Aluminothermic rail head repair processes and materials shall meet the following requirements:

- Aluminothermic rail head repair materials shall be supplied in accordance with the requirements of AS 1085.20. Type and proof testing shall be carried out using the method and frequency defined in AS 1085.20.
- Transport and storage of consumables shall be in accordance with AS 1085.20.
- Approved aluminothermic rail head repair processes and materials are detailed in Appendix 2.

5.6 Rail lubrication

Rail lubrication systems shall be installed to reduce friction at the rail/wheel interface and consequential rail/wheel wear, noise and unnecessary train energy consumption.

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.
- 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
- situations where flanging noise is a problem

5.6.1 Lubricator types

Single pump, single blade lubricators are the preferred type of lubricator.

Current approved lubricators are listed in Appendix 1.

5.6.2 Lubricants

Only approved lubricants (see Appendix 1) shall be used.

Standard lubricant is the minimum requirement, but a high performance lubricant shall be used under severe grade braking locations (more than about 1:50) or at other locations where it is economically justified. In special environmental areas, a biodegradable lubricant may be required.

5.6.3 Installation

1. Lubricators shall be installed in accordance with manufacturer's instructions.
2. All trackside lubricators shall be clamped to the rail. New installations are not permitted to be fixed by bolting through the rail.
3. 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.
4. If at all possible lubricators should be located in moderate radius (600m-1000m) feeder curves ahead of the sharper curves which are the main target.
5. Lubricators should not be positioned in tangent track, or the low rails of curves, or on very large radius curves (greater than 1000m) where no wheel flanging occurs
6. 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.

5.7 Rail adjustment

Rail (except in tunnels as detailed below) shall be installed and adjusted to be stress free at a rail temperature of 35°C. This is the Neutral Temperature adopted for BBRC track.

Rail located more than 50m inside tunnels may be welded where it sits without further adjustment

Rail shall be installed as CWR, LWR or Loose Rail in accordance with configuration requirements.

5.7.1 Long Welded Rail (LWR) design and installation requirements

1. Rails shall be longer than 27.4m.
2. Maximum rail length for new installations shall be 110m in curves <600m radius and 220m lengths for tangents and curves ≥600m radius.
3. Maximum rail length for existing installations shall be 220m.
4. Rail shall be fastened to sleepers with non-resilient fastenings and anchors or a mixture of non-resilient fastenings and resilient fastenings.
6. Mechanical joints in LWR track shall have a gap of 6mm at 35°C.
7. An appropriate track configuration, capable of providing the required resistance for the rail stresses is required. This is detailed in BCS 200.
8. Where non-resilient rail fastenings and "Fair" type rail anchors are specified in the design the minimum anchoring requirements for LWR shall be as specified in Section 5.8.

5.7.2 Continuous Welded Rail (CWR) design and installation requirements

1. Rails shall be > 220m long
2. Rails shall be adjusted to be stress free at a rail temperature of 35°C, except in tunnels as detailed above.
3. Rails shall be installed In accordance with an approved alignment design. Track control marks shall be installed using survey control.
4. CWR shall be installed using an approved process. Approved processes are documented in Appendix 3.

5. Creep monitoring points shall be installed within 14 days of adjustment. Creep monitoring facilities shall be located at every kilometre and half kilometre post. Additional monitoring points may be specified.
6. An appropriate track configuration, capable of providing the required resistance for the rail stresses is required. This is detailed in BCS 200.
7. Rails may be fitted with resilient fastenings or non-resilient fastenings and anchors.
8. Rails fitted with > 1 in 4 resilient fastenings do not require supplementary anchoring.
9. where non-resilient rail fastenings and “Fair” type rail anchors are specified in the design or where ≤ 1 in 4 resilient fastenings are installed, the minimum anchoring requirements for CWR are as specified in Section 5.8.

5.7.3 Prohibited configurations

The following track configurations, in which rail adjustment cannot be assessed with confidence, are prohibited:

- Rails longer than 220m which have not been adjusted
- Rails longer than 220m with no creep marks or pegs
- Rails longer than 220m in curved track with no alignment information available.
- Rails longer than 27.4m with resilient fastenings more than 1 in 3 (unless the rails have been correctly adjusted in accordance with requirements for CWR or a management strategy has been approved by the General Manager in accordance with the requirements detailed in BCS 230.

5.8 Rail anchoring

Rail Anchoring requirements apply to all Class 1 and Class 2 track constructed with timber sleepers and non-resilient fastenings.

On Class 3 and 5 tracks existing anchored track shall be maintained with anchors and existing non-anchored track shall be anchored where necessary to prevent rail creep.

Rail anchoring system configurations include FAIR type rail anchors

Only approved configurations shall be installed.

Rail anchors shall meet the requirements of AS 1085.10.

5.8.1 Anchoring of ballasted welded track

Welded track shall meet the following minimum anchoring requirements.

- Double (or box) anchor every fourth sleeper except at mechanical joints
- Double anchor every second sleeper for a distance of 32 sleepers either side of mechanical joints, starting at the second sleeper from the joint.

Basic anchoring is to be so that sleepers are anchored on both sides on each rail (double or box anchor), except for steep grades as detailed below.

On track with a falling grade steeper than 1 in 80 in the direction of traffic, or at other locations where considered necessary to control rail creep, the anchoring shall be increased by adding single anchoring each second sleeper (or on every sleeper, if necessary) throughout the welded rail length, to prevent rail creep.

5.8.2 Insulated joints in welded track

At mechanical insulated joints EVERY sleeper shall be double anchored for a distance of 32 sleepers on each side of the joint.

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

5.8.3 Anchoring of short rails

5.8.3.1 Lengths shorter than 23m

The anchoring for these with square and staggered joints on ballasted track and bridges shall be as shown in Figure 7. Using these patterns, all anchored sleepers have anchors on both rails.

12m rails - square joints - 6 double anchored sleepers per rail length, placed 5th, 6th, 10th, 11th, 15th and 16th from each joint.

12m rails - staggered joints - 6 double anchored sleepers per rail length, placed 2nd, 5th, 9th, 12th, 15th and 19th from each joint.

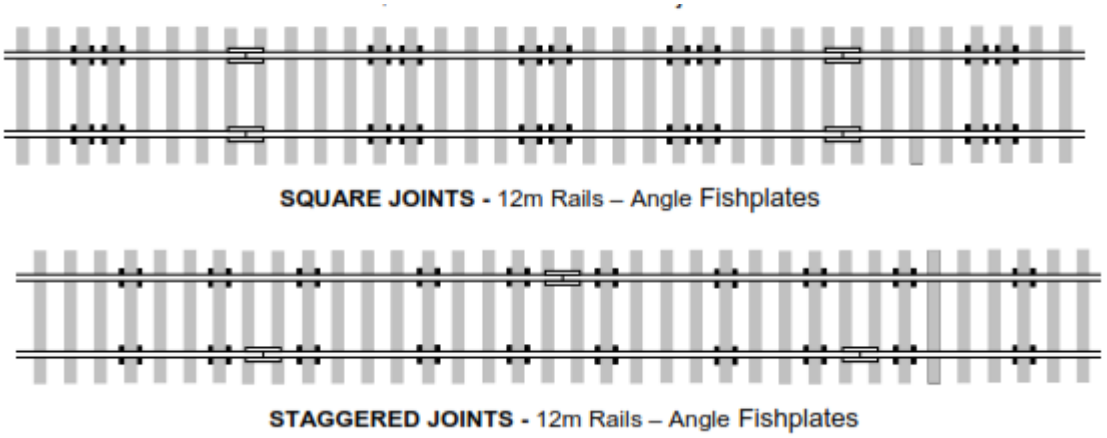


Figure 7 – Anchoring requirements for rail lengths <23m

5.8.3.2 23m and 27m lengths

The anchoring for these on open ballasted track and on bridges shall be as shown in Figure 8.

23m rails - staggered joints - 12 double anchored sleepers per rail length, placed 2nd, 5th, 8th, 12th, 15th, 18th, 21st, 24th, 27th, 31st, 34th and 37th from each joint.

27.5m rails - staggered joints - 14 double anchored sleepers per rail length, placed 2nd, 5th, 8th, 11th, 15th, 18th, 21st, 24th, 27th, 30th, 34th, 37th, 40th and 43rd from each joint.

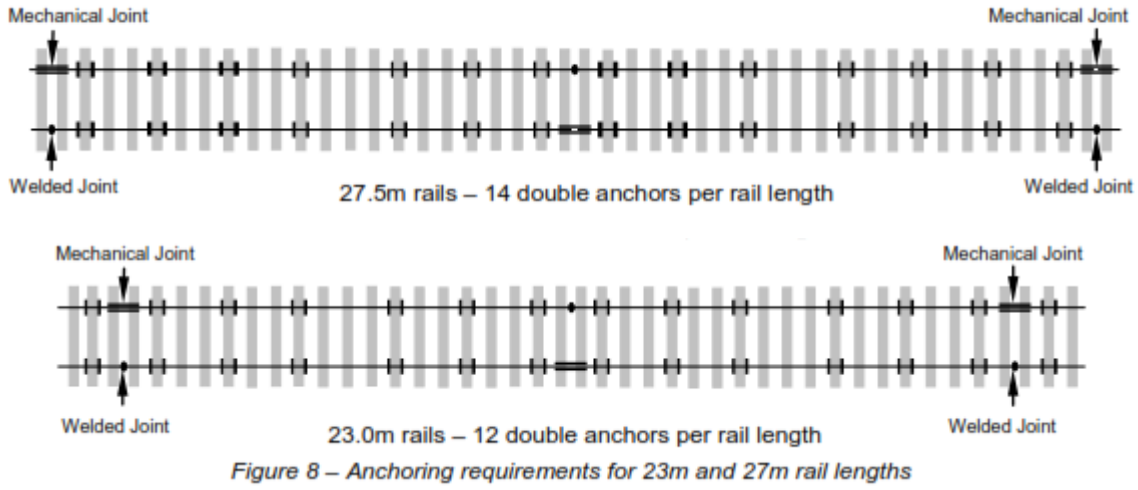


Figure 8 – Anchoring requirements for 23m and 27m rail lengths

5.8.4 Anchoring of welded track on bridges

Transom top openings with spans < 18m

1. Standard anchoring for welded rails on open LWR track as detailed in Section 5.8.1 shall be used on welded rails on these bridges, except as specified below.
2. Anchors shall not be applied on timber bridges where:
   - transoms are not fixed to the girders with bolts drilled through both the transom and girder.
   - transoms are fixed to steel girders by cast iron clip washers, except where an old rail or timber is bolted to the outer ends of the transoms.

   In this case anchoring as in (1) shall apply, but if there is a series of spans giving a total bridge length greater than 30m, then clause (1) of "Transom top openings with spans ≥ 18m long but < 80m" below, shall also apply.
3. On bridges where resilient fastenings are installed in CWR track, normal resilient fastenings are to be installed on the entire length of each span.

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

1. For a distance of 60m from a bridge end, the track shall be double anchored on every second sleeper.
2. On the bridge the track shall be double anchored to every second transom for half the span length, commencing at the fixed end except as indicated in (2) of "Transom top openings with spans <18m".
3. Anchors shall not be applied to transoms that are not fixed to steel or timber girders by bolts drilled through both the transom and girder.
4. On bridges where resilient fastenings are installed in CWR track, normal resilient fastenings shall be installed on one third of the span from the fixed end and Zero Toe Load resilient fastenings installed on the remaining two thirds of the span. Where spans are located on curves < 400m radius, Zero Toe Load fastenings cannot be used.

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

5. Standard anchoring for LWR on ballasted track as detailed in 5.8.1 shall be used on welded rails on these bridges.

Transom top or Ballast top openings with spans ≥ 80m

1. Expansion switches are to be provided at the expansion end of the span(s).

2. For a distance of 60m from a bridge end, LWR track shall be double anchored on every second sleeper.
3. Between expansion switches the rails shall be double anchored to every fourth transom.
4. On bridges where elastic fastenings are installed in CWR track, normal resilient fastenings are to be installed on the entire length of each span.

Structures with Rail Bearing Girders

As the rail on a longitudinal girder cannot be anchored, the number of anchors that cannot be correctly located shall be added to sleepers on each end of the structure.

5.9 Rail at friction buffer stops

Friction Buffer Stops operate by sliding on the rail surface and applying progressive retardation in speed. The condition of rail surface shall not interfere with the free movement of the buffer stop. To achieve this, the following configuration requirements apply to the length of rail along which the buffer stop is designed to move:

- No joints past the friction buffer stop
- No aluminothermic welds
- No other attachments to the rail that would impact on the device (i.e. the rails shall be free from material between the top of the rail to half way down the web).

5.10 Connections to rail

Temporary or permanent connections may be made to rails for:

- signalling currents,
- the connection of other track components, or
- the attachment of wayside devices

The method of attachment shall be by approved welding processes, drilling through the web, or clamping.

Approved methods are detailed in Appendix 4.

The following restrictions apply:

- 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.
- Attachments to the rail foot (web) shall not cause notching

6 Acceptance standards

6.1 Rail

6.1.1 Wheel/rail contact

In track circuited areas, any new rail installed in the track must have its surface cleaned and/or ground to ensure that its running surface is shiny. This will ensure that there is sufficient good electrical contact between train wheels and the rail to operate the signalling correctly. It applies to any rail installed in the track that will have train wheels on it and includes turnouts, catchpoints and bonded insulated joints as well as normal rails and closures.

6.1.2 Rail profiles

6.1.2.1 Profiles and templates

This section has been deleted.

6.1.2.2 Tolerance to template

This section has been deleted.

6.2 Rail joints

The maximum deviation at a discontinuity such as at a joint ("foul joint") is to be 1mm. New joints cut into the track shall have matching profiles at the gauge face and running surface.

6.3 Flashbutt welds

All welds shall be tested for acceptance to the requirements specified in Table 13 prior to the operation of any rail traffic with the exception of slow speed track machines.

Rail defects		
Internal Defects		ALL ultrasonic indicators shall be below reportable limits as detailed in *Table 14*
Visual defects		In accordance with AS 1085.15 Table 2.1
Weld collar tolerances - deviation from rail profile		
at rail web and upperside of rail foot		In accordance with AS 1085.15 Table 2.1
underside of the rail foot		In accordance with AS 1085.15 Table 2.1
Surface alignment tolerances		
Vertical	Tolerance grade AT3	The top surface shall be checked with a 1m straight edge as illustrated in Figure 11 and Figure 12. Additional requirements for testing are detailed in CRN CM 224. The permitted tolerances are shown in *Table 15*.
Horizontal	AT3	The rail alignment shall be checked with a 1m straight edge as illustrated in Figure 13 and Figure 14. The permitted tolerances are shown in *Table 15*.

Table 13 – Acceptance criteria for flashbutt welds

6.4 Aluminothermic welds

All new aluminothermic welds shall meet the following acceptance requirements:

6.4.1 Internal condition

All welds shall be ultrasonically tested. ALL ultrasonic indicators must be below reportable limits as detailed in Table 14.

Defect Type	**Probe movement for Size definition** (mm)
Transverse Defects (TD) Head 70° Probe	<40
Defective Wire Feed Weld (DWFW) Head 70° and T/70 Probe	<25
Bolt Hole Cracked (BH) Web 35° probe	<20
Defective Welds (DW) Head 70° and 0° Probe	<40
Defective Welds Weld Gassing defects DW Gassing Full weld 0° Probe	Loss of weld base signal over <35mm of width of weld
Defective Welds All horizontal web defects (HSW/HWS/FWS)	<15

Defect Type	Probe movement for Size definition (mm)
Defective Welds (DW) Web/Centre foot 35° probe	<25 When testing new Flashbutt welds remove all non-standard foot centre
Defective Welds (DW) Foot Twin 70° Probe	<25
Vertical Split Head (VSH) 0° & Twin 70° Probe	< 50 long or < 3 high
Vertical Split Web (VSW) 0° Probe	Any registration in rail length
Transverse Split web (TSW) 0° Probe	<20
Piped Rail (PR)	<25
Horizontal Split Web (HSW) 35°& 0° Probe	<20
Horizontal Split Head (HSH) 35°& 0° Probe	<25
Head and Web Separated (HWS) 35°& 0° Probe	<20
Foot and Web Separated (FWS) 35°& 0° Probe	<20

Table 14 - Internal rail defect reporting limits

6.4.2 Surface condition

All welds shall be ground to the profile of the rail each side of the weld with no visible deviations from a straightedge.

6.4.3 Geometry

6.4.3.1 On straight track

The top surface and rail alignment shall be checked with a 1m straight edge as illustrated in Figure 11 and Figure 12 (top surface) and Figure 13 and Figure 14 (alignment). The permitted tolerances are as shown in Table 15.

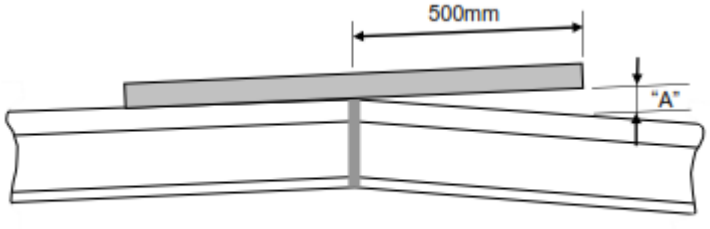


Figure 11 – Weld misalignment tolerance in vertical plane (peaking)

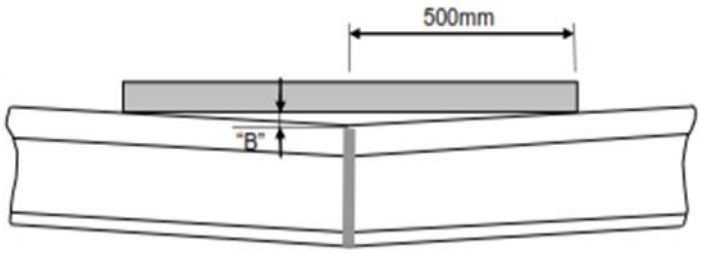


Figure 12 – Weld misalignment tolerance in vertical plane (hollow)

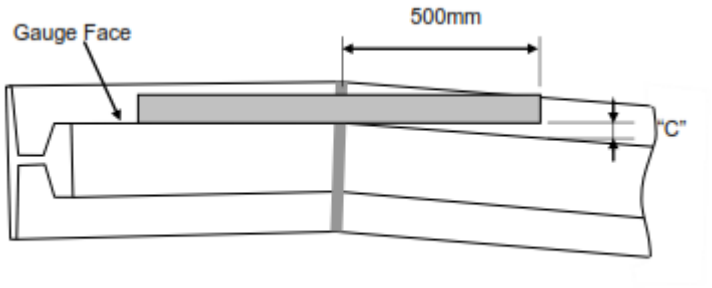


Figure 13 – Weld misalignment tolerance in horizontal plane (tightening)

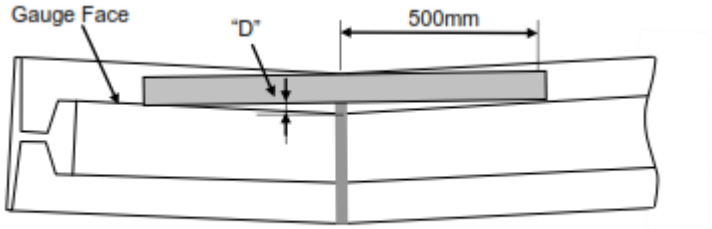


Figure 14 – Weld misalignment tolerance in horizontal plane (widening)

	"A" mm	"B" mm	"C" mm	"D" mm
Weld Surface/Alignment Limits	1.0	0.5	1.0	0.5

Table 15 - Weld Surface/Alignment limits

6.4.3.2 On curved track

Top surface requirements are as for straight track

The horizontal alignment of the newly welded portion of rail must have a curvature consistent with the curvature of the existing rail, and the gauge face at the weld(s) must be smooth and continuous. . There must be no visible "elbow" at the weld.

6.5 Rail head repair welds

All new rail head repair welds shall meet the following acceptance requirements:

6.5.1 Internal condition

All welds shall be ultrasonically tested. ALL ultrasonic indicators must be below reportable limits as detailed in Table 14.

6.5.2 Surface geometry and condition

All welds shall be ground to the profile of the rail each side of the weld with no visible deviations from a straightedge.

The top surface shall be checked with a 1m straight edge as illustrated in Figure 13 and Figure 14. The permitted tolerances are as shown in Table 15.

Weld Surface Limits	"A" mm	"B" mm
For rail head repair welds	0.6	0.3

Table 15 – Head repair weld surface limits

The gauge face will normally be parent rail and shall be visibly smooth and consistent with the curvature of the existing rail

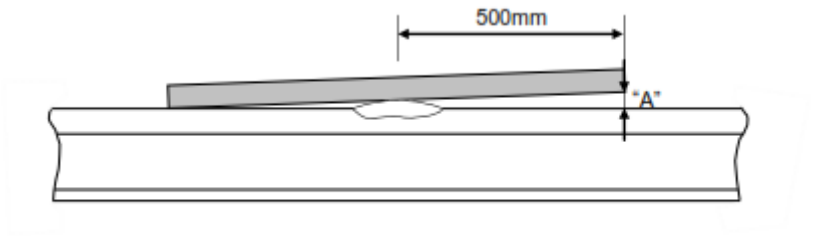


Figure 13 – Head Repair misalignment tolerance in vertical plane (peaking)

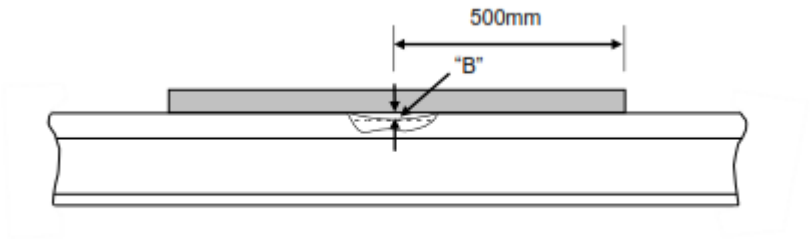


Figure 14 - Head Repair misalignment tolerance in vertical plane (hollow)

Appendix 1 Approved products

Common Item Name	Description	Standard/ Drawing	Manufacturer/ Supplier
Rails			
Rails	Railway rails; head hardened and plain carbon; 50, 53 and 60kg/m	AS 1085.1	One Steel
Rails	Railway rails; head hardened and plain carbon; 47kg	AS 1085.1	Australian Railway Supply Company (ARSC)
Flashbutt welded rail lengths	Railway rails; head hardened and plain carbon; 50, 53 and 60kg/m	AS 1085.1	RailCorp Rail Fabrication Centre
Junction rails	Rails, Junction 60 kg HH rail to 53 kg rail; 2743mm long	RIC Drawing L 5353	
Junction rails	Rails, Junction 53 kg rail to 47 kg rail	RIC Drawing L 5354	
Junction rails	Rails, Junction 47 kg rail to 41kg raill	RIC Drawing L 5355	
Fishplates			
BOW Plates	Steel; bowed for welded joint 47kg rail (pairs)	TKL Dwg A3B12988C	Flowserve
		RIC Drawing 925-712	
BOW Plates	Steel; bowed for welded joint 53kg rail (pairs)	Flowserve Westray Eng	Flowserve Westray Eng
		RIC Drawing 925-712	
BOW Plates	Steel; bowed for welded joint 60kg rail (pairs)	TKL Dwg A3B12990E	Flowserve
Fish Plates	Joint bar, rail Steel; 47kg; 6 holes:	TKL A2B12122/B AS 1085.2	Flowserve
Fish Plates	Joint bar, rail Steel; 50kg; 6 holes:	BHP 2300 AS 1085.2	Westray Eng.
Fish Plates	Joint bar, rail Steel; 53kg; 6 holes	SRA appr DWG AS 1085.2	Westray Eng.
Fish Plates	Joint bar, rail Steel; 60kg; 6 holes	AS 1085.2 SRA appr Dwg BHP 2301	Westray Eng.
Slotted Fish Plates	Joint bar, rail Steel; 50kg; slotted; 6 holes	AS 1085.2	Westray Eng.
Slotted Fish Plates	Joint bar, rail Steel; 53kg; slotted; 6 holes	AS 1085.2 Westray CP437	Westray Eng.
Slotted Fish Plates	Joint bar, rail Steel; 60kg; slotted; 6 holes	AS 1085.2	Westray Eng.
Junction Fish Plates	Junction Plate 47kg/53kg (pairs)	TKL Dwg No A2B09396C Westray Dwg CP479A	Flowserve Westray Eng.
Junction Fish Plates	Junction Plate 53kg/60kg (pairs)	TKL Dwg No A2B08721G Westray Dwg CP478A	Flowserve Westray Eng.
Junction Fish Plates	Bowed Junction Plate 53kg/60kg (pairs)	TKL Dwg A2B113191A	Flowserve

Common Item Name	Description	Standard/ Drawing	Manufacturer/ Supplier
Rail Fastenings			
Fishbollts	Bolt, fishplate M24; 100mm lg; heat treated; oval neck; cup head; c/w hex nut & spring washer;	RSA Dwg 205A 323D AS 1085.4)	
Fishbollts	Bolt, fishplate M20; 100mm lg; heat treated; oval neck; cup head; c/w hex nut & spring washer;	RSA Dwg 205A 323D AS 1085.4)	
Fishbollts	Bolt, fishplate M22; 115mm lg; heat treated; oval neck; cup head; c/w hex nut & spring washer;	RSA Dwg 205A 323D AS 1085.4)	Greg Sewell Forgings
Fishbollts	Bolt, fishplate M24; 140mm lg; heat treated; oval neck; cup head; c/w hex nut & spring washer;	RSA Dwg 205A 323D AS 1085.4)	Greg Sewell Forgings
Swage lock fasteners			
Pin, Huck	1” dia pin; Round Head; Fishplate	C50LR-BR32-64	Alcoa
Pin, Huck	1” dia pin; Thread Head; Fishplate	C50LH-BR32-64	Alcoa
Lock Collar	1 “Lock Collar for 1” (32) pins	LC-2R32G	Alcoa
Avdelock swage Fastenings	Avdelock swage Fastenings	PDS 5 Product Data Sheet No 25 RT	Avlock Acument Global Technologies
Washer	24mm structural washer for 1” (32)bolts (pack under collar only)	M24	Alcoa
Rail Clamps			
Robel Clamps	Rail clamp for mechanical rail joint; nut locking device with safety locking flap and safety locking bar; Blue – 41 and 47kg rail White – 53 and 60kg Brown – 50kg	Robel part number 68.05	Robel
G-Clamps	Rail Clamp C "G" Type; Steel	RIC Dwg 177A-26A	
Insulated Joints			
Insulated Fish Plates	Steel; 53kg; 6 holes; for mechanical insulated joints	RIC Dwg M04-216-39P91 Thermit Dwg 06-141C Westray Dwg CP522-1	Thermit Australia, Westray Eng.
Insulated joint kit	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	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	‘Hercules’ NIJ 721 series joints (to be used with AS60 rail)	Norfast NIJ-6	Norfast Martinus Rail
Bonded Insulated Joints	47kg; 4.57m lg; 0 versine; Std. Carbon;	AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	50kg; 3.43m lg; 0 versine; std. carbon;	AS 1085.12	RailCorp Bathurst Workshops

Common Item Name	Description		Standard/ Drawing	Manufacturer/ Supplier
Bonded Insulated Joints	53kg; 3.43m lg; 0 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	53kg; 3.43m lg; 3 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	53kg; 3.43m lg; 6 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	53kg; 4.57m lg; 0 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	53kg; 4.57m lg; 5 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	53kg; 4.57m lg; 10 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 3.43m lg; 0 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 3.43m lg;3 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 3.43m lg; 6 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 4.57m lg; 0 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 4.57m lg; 5 versine; std. carbon; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Bonded Insulated Joints	60kg; 4.57m lg; 10 versine; head hardened; 15° cut;		AS 1085.12	RailCorp Bathurst Workshops
Rail Lubrication				
Lubricators	P&M (Fessl)			Existing Applications only
	RTE 25 (clamp-on type)			Rail Track Equipment P/L
	QHI Rail Lubricurve 50 and 10-20			QHI Rail Ltd WPS Ptl Ltd
	Portec PW Series Lubricators			Portec Rail Products
Lubricants	Lubricants	Type	Use with lubricators	
	ROCOL Rail Curve Grease	High Performance	All Lubricators	ROCOL
	CALTEX 904	Standard	All Lubricators	CALTEX
	FUCHS 234GOWX	High Performance Environmentally Friendly	All Lubricators	FUCHS
Rail Anchors				
Rail anchors	To suit 41, 47 and 53kg/m rail		AS 1085.10	Unit

Common Item Name	Description	Standard/ Drawing	Manufacturer/ Supplier
Rail Templates			
Template	41kg Rail bolt hole marking for drilling and cutting	CRN CP 202	
Template	47kg Rail bolt hole marking for drilling and cutting	CRN CP 202	
Template	53kg Rail bolt hole marking for drilling and cutting	CRN CP 202	
Template	60kg Rail bolt hole marking for drilling and cutting	CRN CP 202	

Appendix 2 Approved welding processes

Rail (kg/m)	Aluminothermic Welds					
	Thermit			Railtech		
	Process	Part Number	Weld Hardness (HBN)	Process	Part Number	Weld Hardness (HBN)
SHORT PREHEAT (Standard Gap Welds)						
41	SKVE Z70 SU					
41	SKVE Z90 SU					
47	SKVE Z90 SU	404745-01	260-300	PLK CJ; X	79700007	280-320
50	SKVE Z90 SU			PLK CJ; X	79700009	280-320
50	SKVE Z100 SU					
50	SKVE Z110 SU					
53	SKVE Z90 SU	405345-01	260-300	PLK CJ; X	79800006	280-320
60	SKVE Z90 SU	406045-01	260-300	PLK CJ; X	79700003	280-320
60	SKVE Z100 SU					
60HH	SKVE Z110 SU	406045-03	340-380	PLK CJ; HH	79700002	340-380
LONG PREHEAT (Standard Gap Welds)						
41	SMWF Z70		260-300			
47	SMWF Z90		260-300	AP W		260-300
53	SMWF Z90		260-300	AP W		260-300
60				AP W		260-300
WIDE GAP (Short Preheat)						
47				WG68; X CJ	75800019	280-320
53				WG68; X CJ	75800016	280-320
60				WG68; X CJ	75800015	280-320
JUNCTION WELDS (Standard Gap Welds, Short Preheat)						
30/40 or 41	SKVF Z70		210-250			
41/47	SKVF Z70		260-300			
47/53	SKVE Z90 SU JN		260-300	PLK CJ; X	79707002	280-320
53/60	SKVE Z90 SU JN		260-300	PLK CJ; X	79707004	280-320
HEAD REPAIR WELDS						
Nil						

Appendix 3 Approved rail adjustment processes

Common Item Name	Description	Standard/ Drawing	Manufacturer/ Supplier
Long Welded Rail		CRN CM 223	
Continuous Welded Rail		CRN CM 223	
Rail Out – Rail In		CRN CM 223	

Appendix 4 Approved rail connection methods

Connection Method	Description	Standard/ Drawing	Manufacturer/ Supplier
Welding			
Cad-Welding	Erico – Signals approved process		Erico
Drilling			
Rail Joint Bolt Holes		CS 220 – Section 5.4.1.1	
Clamping			
Clamping attachment for Rail Lubricators			Rail Track Equipment P/L
Clamping attachment for Rail Lubricators			QHI Rail Ltd WPS Ptl Ltd
Clamping attachment for Rail Lubricators			Portec Rail Products