TRACK AND CIVIL INFRASTRUCTURE

CODE OF PRACTICE

VOLUME THREE - TRAM SYSTEM [CP3]

RAIL AND RAIL JOINTS

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1.0 PURPOSE AND SCOPE

1.1 PURPOSE

The purpose of this part is to set standards to ensure that:

a) the selection of rails and rail joints is appropriate to the requirements of the tramline;

b) appropriate inspection and maintenance procedures are carried out;

c) if rail or rail joint failure occurs, appropriate action is taken;

d) the selection of rail lubricators is appropriate to the requirements of the tramline;

e) appropriate inspection and maintenance procedures of rail lubricators is carried out.

1.2 PRINCIPLES

This part complies with the principles set out in the “Code of Practice for the Defined Interstate Rail Network”, volume 4, part 2, section 1.

1.3 SCOPE

1.3.1 Rails, rail joints and rail lubrication

This part specifies general procedures for the design/rating, acceptance, monitoring and maintenance of:

a) new and recycled rail;

b) temporary and permanent joints including flash butt welded joints, alumino-thermic and non-welded (i.e. fishplated) joints;

c) rail lubricators and rail lubrication.

1.3.2 Rail end batter, wear, repair welding and weld misalignment

This part specifies general procedures for managing:

a) rail end batter;

b) rail wear;

c) repair welding of “V” crossings, rail end batter and wheel burns with manual arc or MIG repair welds;

d) welded rail misalignments.

1.4 REFERENCES

1.4.1 Industry code of practice and report

a) Code of Practice for the Defined Interstate Rail Network, volume 4 (Track, Civil and Electrical Infrastructure), part 2 (Infrastructure Principles), section 1: Rails

b) Code of Practice for the Defined Interstate Rail Network, volume 4 (Track, Civil and Electrical Infrastructure), part 2 (Infrastructure Principles), Appendix E : Target rail profiles for grinding.

c) Railways of Australia (Australasian Railway Association) report ‘WZ/89/A/92 Ultrasonic Testing of Rail in Railway Applications.’

1.4.2 **Australian Standards**

AS 1050.1 Methods for the analysis of iron and steel Part 1: Sampling iron and steel for chemical analysis
AS 1085.1 Railway permanent way material Part 1: Steel rails
AS 1085.1 (1980) Railway permanent way material Part 1: Steel rails
AS 1085.2 Railway permanent way material Part 2: Fishplates
AS 1085.4 Railway permanent way material Part 4: Fishbolts and nuts
AS 1085.7 Railway permanent way material Part 7: Spring washers
AS 1085.11 Railway permanent way material Part 11: Head-hardened rails
AS 1085.12 Railway permanent way material Part 12: Glued insulated joint assemblies
AS 1085.15 Railway permanent way material Part 15: Aluminothermic rail welding
AS 1554 Structural steel welding – Part 1: Welding of steel structures
AS 2083 Calibration blocks and their methods of use in ultrasonic testing

1.4.3 **TransAdelaide documents**

a) **CP3**
CP-TS-972: Part 2, Structure and application
CP-TS-973: Part 3, Infrastructure management and principles
CP-TS-980: Part 10, Track support systems
CP-TS-983: Part 13, Points and crossings
CP-TS-984: Part 14, Rail stress control
CPRD/PRC/046 Records Management

b) **Quality and Railway Safety Procedure Manual**
QP-IS-002: Developing Process Documentation
QP-IS-501: Document and Data Control

1.4.4 **TransAdelaide drawings**

Note: Drawings of TransAdelaide temporary or permanent rail joint designs are shown in table 4.2.

2.0 NEW RAIL

2.1 STANDARD NEW RAIL TYPES

2.1.1 **Preferred rails**

The preferred new rail size shall be AS 41 kg for open track. For points and crossings see CP-TS-983 (Points and crossings).

2.1.2 **Conforming with standards**

New rail shall conform with the following criteria:

a) 41 kg rail cross section shall comply with AS 1085.1 (1980). All other properties shall comply with AS 1085.1 or AS 1085.11.

b) Certification of compliance with relevant standards shall be supplied.

2.2 NON-STANDARD NEW RAIL TYPES

Rail sizes other than those specified in sub-section 2.1 may be used subject to demonstration, through appropriate analysis and/or testing, that they are suitable for the operational task. Rail wear limits for these alternative rail sizes should be determined during the process. CP-TS-973 (Infrastructure management and principles) outlines the processes, which shall be used to determine the acceptability of any new rail.

2.3 RAIL ACCEPTANCE

a) New rail prior to its use in track shall be assessed and certified for use in accordance with sub-sections 2.1 or 2.2.

b) Recycled rail prior to its reuse in track shall be assessed and certified for use in accordance with section 3.0.

2.4 MINIMUM RAIL LENGTHS

a) The minimum rail lengths in points and crossings shall be as shown on authorised drawings.

b) Except as specified in sub-clause (a), the preferred minimum length rails used on main lines shall be as shown in table 2.1:

Table 2.1: Minimum rail lengths

Straight or curved track	Welded joints both ends; welded joint one end, fishplated joint the other	Fishplated joints both ends
On straight track or curves > 800m radius	3m	as shown in CP-TS-980 (Track support systems)
On curves ≤ 800m radius	5m	

Except as specified in sub-clause (a), the absolute minimum rail length (anywhere) shall be 2.2m

3.0 RECYCLED OR PART WORN RAIL

3.1 RECYCLED OR PART WORN RAIL

Recycled or part worn rail defines all rail that has previously carried traffic, including rail used for closures and inserts. Prior to use recycled or part worn rail shall be examined for conformity with the criteria in table 3.1:

Table 3.1: Recycled or part worn rail

FACTOR	SPECIFICATION	METHOD OF TEST	FREQUENCY/ TIMING OF TEST	METHOD OF ASSESSMENT
Defects in rails and welds	Defects should be identified and classified as detailed in sections 6.0, 8.0 and 12.0.	Refer to sections 6.0, 8.0 and 12.0.	Ultrasonic testing as required by figure 5.1.	Refer to clauses sections 6.0, 8.0 and 12.0.
Wear limits	Refer to section 9.0.	Gauge or measurement of wear	Once only prior to unrestricted service	Refer to section 10.0
Metallurgical properties	No testing is necessary if the rail conforms to AS 1085.1 or the relevant superseded Australian Standard or has extensive proven service under the relevant operating conditions	Not applicable	Not applicable	Not applicable
	Otherwise for each rail type determine suitability in terms of: a) Ultimate yield strength b) Chemical composition c) Inclusions; d) Impact resistance; e) Hardness; f) Microstructure	Applicable Australian and International Standards	Once only prior to use of rail type	Review by metallurgist competent in rail examination, testing or evaluation
Location of bolt holes in rail to be welded	The distance from the edge of the bolt hole to the rail end shall be no less than 65mm	Direct measurement	Once only prior to welding	Compare with specification
Adjacent welds	Welds should be no closer than 2.2m from the next weld or the end of the rail. Welds or rail ends should not be located closer than 1.5m from the centre of a glued insulated joint.	Direct measurement	Once only prior to welding	Compare with specification
Adjacent non-welded joints	Joints should be no closer than 6m.	Direct measurement	Only once prior to installation.	Compare with specification
Rail end straightness	The rail end straightness should be limited to that which permits the final weld or mechanical joint to comply with section 12.0 on rail discontinuities.	Direct measurement		Compare with specification
Rail twist	Complies with to AS 1085.1 or the relevant superseded Australian Standard for twist.	Direct measurement	Once only prior to unrestricted service	Compare with specification
Discontinuities	Refer to section 12.0	Refer to section 12.0	Once only prior to unrestricted service	Compare with specification
Rail cross-section	Rail conforms to AS 1085.1 or the relevant superseded Australian Standard	Check branding	Only once prior to use.	Compare with specification
Gauge face angle	Refer to sub-section 9.6.	Gauge or profile measurement	Only once prior to use.	Compare with specification

4.0 RAIL JOINTS

4.1 RAIL JOINT METHODS

Methods of joining rail to provide continuous support may include the following:

a) Continuously welded rail (CWR) [see sections 5.0 and 6.0].

b) Non-welded rail i.e. mechanically jointed rail [see sections 7.0 and 8.0].

c) A combination of welded and non-welded rail e.g. long welded rail. Note that joints will need to be of adequate strength and the rail should be adequately restrained. The centre portion of long lengths may need to be treated as for CWR.

Associated construction and maintenance instructions are specified in CP-TS-984 (Rail stress control).

4.2 CUTTING OF RAIL

Rail ends in insulated joints should comply with AS 1085.12. The cut should be in a vertical plane and in the plan view may be square or at an angle of 15º.

Rail saw cutting is the preferred method of cutting rail and it is the only method permissible for preparation of closures to be used for later welding operation. Flame cutting of rails is permitted when welding is to be carried out subject to the conditions set out below:

a) The method may not be used in any circumstances on head hardened rail except where welding is to be carried out immediately (i.e. within 30 minutes). If this is not possible, 30mm should be cut off the cooled rail ends immediately prior to welding.

b) For standard carbon rails, flame cut rails should be welded in the same work shift. If this is not possible, 30mm should be cut off the cooled rail ends immediately prior to welding.

c) The method may not be used in preparing rail ends for installation of a permanent non-welded rail joint.

Both ends of the rail to be welded must be of the same type i.e. either both flame cut or both sawn.

Flame cut rail ends under traffic should be plated with a temporary joint and have a speed restriction of 20km/h or less (depending on the joint design) imposed.

4.3 DRILLING HOLES IN RAIL

The drilling of holes in rails should be minimised, e.g. by using rail mounted equipment that does not require drilling of rail.

Marking the centre of the hole to be drilled should be carried out using an appropriate template or equivalent. Holes should be drilled square to the web via use of an appropriate guidance mechanism. Drilling requires appropriate cooling of the drilling tool.

Under no circumstances are flame cut holes permitted in rail or other track components.

The location of boltholes for the installation of mechanical rail joints should be in accordance with the dimensions defined in AS 1085.2 and AS 1085.12. In all other cases, the centre of drilled holes should be within 5mm of the neutral axis of the rail and for all sizes of 41kg/m and greater should not be greater than 27mm in diameter.

5.0 WELDED RAIL JOINTS AND REPAIR WELDING

5.1 RAIL WELDING OF JOINTS

5.1.1 **Rail joint weld process**

Recommended types of weld processes for joining rails include the following:

a) Aluminothermic

b) Flashbutt

c) Kirby joint (refer sub-section 5.4).

Rail welding processes should comply with clauses 5.1.2 and 5.1.3

5.1.2 **Flashbutt welding**

Welding rail ends together using flashbutt welding should be carried out using a specified process as set out in table 5.1.

5.1.3 **Aluminothermic welding**

a) Aluminothermic weld materials should be supplied in accordance with AS 1085.15. Type and proof testing should be carried out using the method and frequency defined in AS 1085.15.

b) Welding rail ends together and repairing the rail running surface using alumino-thermic welding should be carried out using a specified process set out in table 5.2.

c) Transport and storage of weld consumables should be in accordance with AS 1085.15. Consumables affected in any way, which will impact on the integrity of the final weld, should not be used.

5.2 REPAIR WELDING

Manual metal arc or metal inert gas welding

Repairing the rail running surface using manual metal arc (MMA) or metal inert gas (MIG) welding should be carried out using a specified process as set out in table 5.3. These welding processes should not be used for joining rail.

5.3 OTHER WELDING PROCESSES

Welding process types other than the above (e.g. gas pressure welding to join rail) should only be used following testing and commissioning in accordance with CP-TS-973 (Infrastructure management and principles). This should involve a stringent validation process involving metallurgical analysis and thorough laboratory and field testing prior to general application in track.

5.4 KIRBY JOINT

a) A Kirby Joint is described as “the joining of two rails by fillet welding of a steel base plate to the bottom of the foot of the rails and straps on the tops of the foot of the rails and side of the web, if appropriate. A vee butt weld may also be employed to join the rail heads in defined situations. At junctions of different rail profiles, the joint utilises steel spacer blocks or packers.”

b) Kirby joints are used in points and crossings to join carbon rails to cast manganese steel crossings or switch assemblies [refer CP-TS-983 (Points and crossings].

Table 5.1: Flashbutt welding process

FACTOR	SPECIFICATION	METHOD OF TEST	FREQUENCY OR TIMING OF TEST	METHOD OF ASSESSMENT	ACTIONS
Welding practices	Use equipment, manufacturer's method or other method approved by TransAdelaide Performance specification should include at least: Welding current Upset force or pressure Upset displacement Welding time	Weld completion report by welder certifying conformance with specification. Visual observation of welding process Check graph or meter	Every weld immediately after completion	Against specification	When a process non-conformance is identified possible corrective actions include: Stop welding Reassess process Readjust settings Rework
Worker competency and training	Welder to be competent and hold current certification in flashbutt welding	Audit of welder competency	Welders should be recertified at least every two years More frequent assessment may be necessary where evidence of non-conformance is identified.	Competency assessment against specification	Retraining of welder or withdraw certification
Post weld testing (see note)	External visual inspection. Refer to sections 6.0 (welded rails) and 12.0 (discontinuities).	Visual: Weld certification that the weld has been visually inspected and no recordable defects have been found	Every weld immediately after welding	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).
	Internal inspection as specified in section 6.0 (welded rails).	Ultrasonic testing: Weld certification that correct practices and equipment have been used and that no recordable defects have been found	Every weld at production or within 90 days of installation into track.	As specified in section 6.0 (welded rails).	As specified in section 6.0 (welded rails).

Note: TransAdelaide may specify strength testing and macroscopic testing of welds following welding machine malfunction, overhaul, change of rail section or work shift.

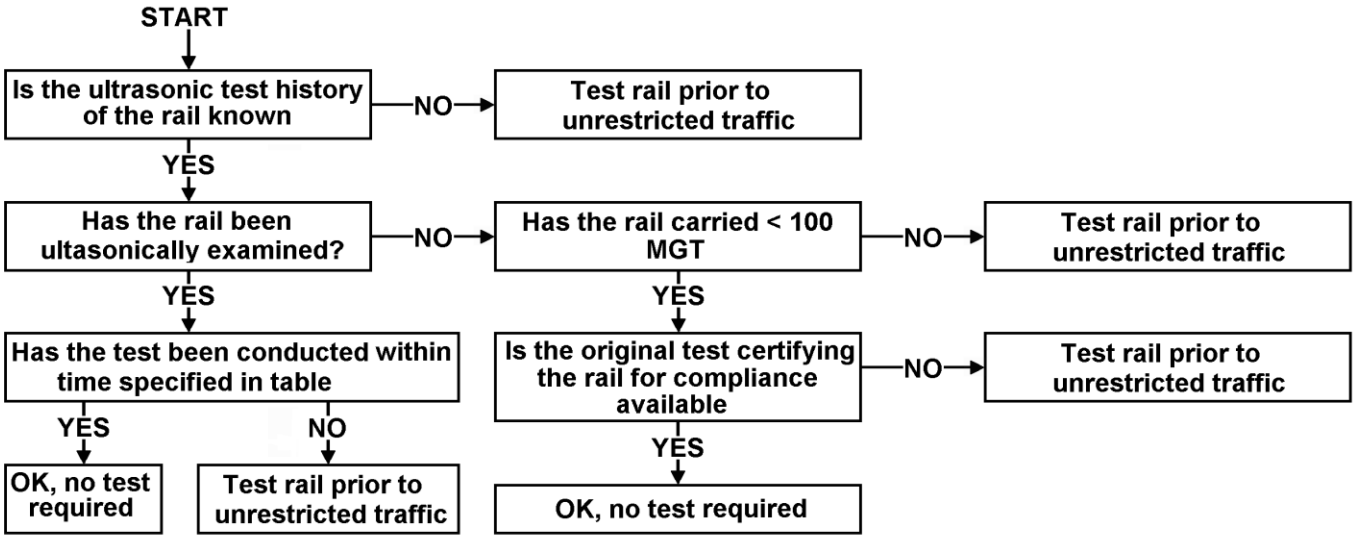
Table 5.2: Aluminothermic welding process

FACTOR	SPECIFICATION	METHOD OF TEST	FREQUENCY OR TIMING OF TEST	METHOD OF ASSESSMENT	ACTIONS
Welding practices	Manufacturer's method or other method approved by TransAdelaide	Weld completion report by welder certifying conformance with specification. Visual observation of welding process	Every weld immediately after completion	Against specification	When a process non-conformance is identified possible corrective actions include: Stop welding Reassess process Rework
Worker competency and training	Welder to be competent and hold current certification in alumino-thermic welding	Audit of welder competency	Welders should be recertified at least every two years More frequent assessment may be necessary where evidence of non-conformance is identified.	Competency assessment against specification	Retraining of welder or withdraw certification
Post weld testing	External visual inspection. Refer to sections 6.0 (welded rails) and 12.0 (discontinuities).	Visual: Weld certification that the weld has been visually inspected and no recordable defects have been found	Every weld prior to unrestricted traffic immediately after welding	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).
	Internal inspection as specified in section 6.0 (welded rails).	Ultrasonic testing: Weld certification that correct practices and equipment have been used and that no recordable defects have been found	Every weld within 90 days of weld being installed in track.	As specified in section 6.0 (welded rails).	As specified in section 6.0 (welded rails).

Table 5.3: Manual metal arc and MIG repair welds - process

FACTOR	SPECIFICATION	METHOD OF TEST	FREQUENCY OR TIMING OF TEST	METHOD OF ASSESSMENT	ACTIONS
Materials	All materials should be supplied to an Australian Standard	To be approved by TransAdelaide	Prior to use	Against the specification	As necessary
Welding practices	Practices for surface preparation and weld process to be approved by TransAdelaide	Weld completion report by welder certifying conformance with specification.	Every weld immediately after completion	Against specification	Stop the use of the welding procedure Reassess the process.
Worker competency and training	Welders should be assessed as competent. Dependent on the risk this may necessitate certification similar to that under AS 1554 for special purpose welding	Audit of welder competency	Welders should be recertified at least every two years More frequent assessment may be necessary where evidence of non-conformance is identified.	Competency assessment against specification	Retraining of welder or withdraw certification
Post weld testing	External visual inspection. Refer to sections 6.0 (welded rails) and 12.0 (discontinuities).	Visual: Weld certification that the weld has been visually inspected and no recordable defects have been found	Immediately after all welds.	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).	As specified in sections 6.0 (welded rails) and 12.0 (discontinuities).
	Internal inspection as specified in section 6.0 (welded rails). Particular attention should be given to problems that may occur due to internal defects created by the welding process	Ultrasonic testing: Weld certification that correct practices and equipment have been used and that no recordable defects have been found. No testing available for manganese steel products.	Every weld at production or within 90 days of installation into track. Only necessary for defect repairs greater than 5mm deep.	As specified in section 6.0 (welded rails).	As specified in section 6.0 (welded rails).

Figure 5.1: Rail acceptance – ultrasonic test flow diagram



6.0 MONITORING AND MAINTENANCE OF WELDED RAILS

6.1 INSPECTION OF RAIL AND RAIL JOINTS

a) This section prescribes the minimum requirements for inspection and response to rail and welded joint conditions. For non-welded joints see section 8.0.

b) Known defects shall be positively identified in track with indelible marking.

c) Defects other than those described in this sub-section may be identified in track. These defects should be responded to, taking into account both the underlying causes of the defect and its impact on the integrity of the track structure.

d) Inspection, assessment and maintenance actions of rail and welded rail joints shall include the specific conditions shown in table 6.1:

Table 6.1: Rail and welded joint inspections and assessment

Type of inspection or action	Specific conditions to look for or other actions
Scheduled rail and welded joint inspections	
Walking inspections	a) Identify visually, and report, obvious rail defects and conditions (i.e. indicators of a defect) that may affect the integrity of the track structure including the following: 1) broken rails and rail welds; 2) rail and rail weld deformations and discontinuities; 3) wheel burns; 4) damage to rail surface or section; 5) unusual patterns of gauge face contact; 6) unusual vehicle tracking patterns; 7) rail corrugation; 8) rail crippling; and 9) other obvious indications of defects such as bleeding. b) Where track circuits are used, these should be considered as an additional method to detect rail failures. c) Intervals between walking inspections shall not exceed 31 days.
Continuous ultrasonic testing	Continuous ultrasonic testing - shall be undertaken every 12 months during the service life of rails to identify and report defects detectable by ultrasonic inspection. Technical aspects of this testing should be based on the Railways of Australia (Australasian Railway Association) report 'WZ/89/A/92 Ultrasonic Testing of Rail in Railway Applications.'

Table 6.1*(continued)*: Scheduled rail and welded joint inspections and assessment

Type of inspection or action	Specific conditions to look for or other actions
Unscheduled rail and welded joint inspections	
Detailed inspection	A detailed visual inspection should be carried out: a) for all new welds (see tables 5.1, 5.2 and 5.3); and b) where the response following the detection of a rail or weld defect is 'observe' (see Appendix 2).
Manual ultrasonic testing	a) Manual ultrasonic testing should be carried out in the following situations: 1) at new aluminothermic and flashbutt welds; 2) to confirm suspected defects as indicated by the continuous ultrasonic inspection; 3) where there are suspected defects as found by the walking inspection; 4) when known defects are to be re-inspected and re-assessed. b) Probe configurations shall be carefully selected for the defect being examined. As a basis the following standards shall be used to derive the required work instructions: 1) AS 2083 for calibration of equipment; 2) AS 1085.15 for weld test procedure.
Other detailed inspections	Other detailed inspections may be used in conjunction with ultrasonic inspection, for example magnetic particle, dye penetrant, X-ray, eddy current and magnetic induction.
Documentation	In addition to the general documentation required, the following documentation relating to rail and weld defects should be maintained: a) specifications or work instructions for ultrasonic testing; b) defective rail/weld reports; c) defect listings and status; and d) reports of defect removal.
Assessments and action	Defects detected from inspections should be assessed and reported in accordance with the classification, position and sizing codes as specified in Appendix 2.

6.2 REFERENCE TO APPENDIX 1

Appendix 1 shows the following:

a) defect type codes;
b) defect position codes;
c) defect sizing codes.

6.3 REFERENCE TO APPENDIX 2

Appendix 2 lists the various types of rail defect. The following information is provided for the various defects:

a) description;
b) origins;
c) manner of propagation;
d) visual detection information;
e) failure mode information;
f) response times and actions.

7.0 NON-WELDED, INCLUDING MECHANICAL, RAIL JOINTS

7.1 TYPES OF NON-WELDED RAIL JOINTS

Non-welded rail joints may be classified as either:

a) Permanent rail joints (including glued insulated joints and expansion joints) intended for use in track where special inspections or speed restrictions are not required.

b) Temporary joints intended for temporary jointing of rails to permit short term passage of trams generally at reduced speed and requiring special inspections when in use.

7.2 DESIGN SPECIFICATION

Rail joints, including components and assembly details, shall be of an approved design and shall be assembled and used in accordance with the design specifications. The design specifications shall include:

a) material specification;

b) assembly requirements, e.g. fastening tension and special locking devices;

c) conditions for use;

d) inspection frequency;

e) maintenance requirements, e.g. ensuring free movement of sliding joints;

f) speed restrictions for temporary joints.

7.3 MATERIAL CERTIFICATION

Materials shall be certified as having been manufactured to the appropriate standards and specifications.

7.4 PERMANENT RAIL JOINTS

7.4.1 Fixed or free joints

These joints may be either fixed which are those designed not to move, or free, which are those that have a designed movement.

7.4.2 Types of permanent joints

Types of permanent joints include:

a) standard bolted joint (free);

b) mechanical (fixed) - swage fastened e.g. as used in points and crossings;

c) mechanical insulated (fixed) - normal insulated joint (liners, ferrules, and end posts), coated fishplates;

d) glued insulation (fixed) - predominantly used in CWR and considered as a single structural unit;

e) junction joint (free) - used to join different rail sizes.

7.4.3 Swage lock fastenings

In crossings, turnouts and other locations where fixed joints are used, the use of swage lock fastenings in lieu of bolts is an alternative method of fastening. Care should be taken however to ensure that the joint components can support the forces imposed by this type of fastening due to the tensile loading across the fastening.

7.4.4 **Approved designs**

A junction or other permanent joint not covered by Australian Standards (see clause 7.6.5) shall be either a TransAdelaide standard design as in table 7.2, or equivalent. An alternative design shall:

a) undergo commissioning which includes a stringent validation process, metallurgical, physical and extensive field testing;

b) be a current proven design; or

c) be equal to or exceed the performance of current proven designs.

7.4.5 **Insulated joints**

a) All new insulated joints should be Grade A insulated joint assemblies in accordance with AS 1085.12 and use 6 hole joint bars.

b) Rail ends may be angle cut as provided for in AS 1085.12.

c) Insulated joints should be centrally suspended between sleepers;

d) In general, insulating materials that encapsulate fishplates are unsuitable for swage lock fastenings without the application load spreading bars.

7.4.6 **Other joints**

Expansion switches, junctions and other permanent joints not covered by AS 1085 should be supplied to a design approved by TransAdelaide.

7.5 TEMPORARY RAIL JOINTS

Types of temporary rail joints shall include the joints shown in table 7.1:

Table 7.1: Types of temporary rail joints

Type	Where used	Speed limit	Special action
Clamped fishplates	Used at a broken/cut rail or a defective weld	20km/hr	Remove as soon as practicable but no longer than 7 days; inspect daily
Special fishplates	Used for a defective butt weld	None	Routine inspection; plates not to remain in place once weld has broken (i.e rail to be repaired)
Construction joint	To secure a joint prior to welding	20km/hr	Track maintenance workers to be present and inspect after each tram movement
6 hole plates with 4 bolts	Generally 2 centre bolts not used. Only used where it is intended to weld the track	None	Weld joint as scheduled

Note: Rail lengths between 3m and 12m may be used with a temporary joint during relaying or rail defect removal

7.6 STANDARD BOLTED RAIL JOINTS

7.6.1 **Lubrication of free joints**

A free (sliding) joint shall be lubricated annually to ensure free movement.

7.6.2 **Square and staggered joints**

a) The preferred configuration for joints shall be “square” i.e. joints on opposite rails are in the same sleeper bed.

b) Where staggered joints are used, the “stagger” is defined as the distance measured along the centre line of the track between opposite joints, which are not “square”.

c) Staggered joints shall have a minimum “stagger” of 3 metres.

d) No more than three joints having a “stagger” of between 3m and 6m shall follow in succession.

e) There shall be no limit on the number of joints with a “stagger” of more than 6m.

f) Where staggered joints are used the effect on vehicle resonance should be taken into consideration.

7.6.3 **Suspended joints**

It is preferred that joints shall be centrally suspended between sleepers. Where this not possible joints should be centrally supported.

7.6.4 **Relevant Australian Standards**

Manufactured fishplated rail joint assembly components shall conform to the requirements of the appropriate Australian Standard. These standards generally define the requirements with respect to materials and material tests, manufacture, design and specification of the component, and component testing and compliance:

a) Fishplates - AS1085.2

b) Fishbolts and nuts - AS1085.4

c) Spring washers - AS1085.7

d) Glued insulated joints - AS1085.12

7.6.5 **Drawings of rail joints**

Drawings of TransAdelaide rail joint designs are shown in table 7.2:

Table 7.2: Drawings of temporary or permanent rail joints

Drawing no.	Date	Title
326-A2-84-0476	18/05/84	FISHPLATES AND DETAILS - FISHPLATE 82 AS - 94KG
326-A2-84-1282	15/10/84	FISHPLATED JOINT - FISHBOLT M24 X 137MM WITH SQUARE NUT
326-A2-84-1558	22/11/84	FISHPLATED JOINT - FISHBOLT M22 X 110MM WITH SQUARE NUT
326-A3-84-1253	15/10/84	FISHPLATED JOINT - SPRING WASHER FOR M24 BOLT
326-A3-84-1562	26/11/84	FISHPLATED JOINT - SPRING WASHER FOR M22 FISHBOLT
326-A2-84-1281	15/10/84	FISHPLATED JOINT - SPECIAL FISHPLATE - BROKEN THERMIT WELDS 47KG AS RAIL
326-A2-85-0223	30/01/85	FISHPLATED JOINT - FISHPLATE 47 KG AS FOR USE WITH FISHPLATE CLAMP
326-A1-84-0652	24/05/84	FISH PLATES - CLAMP FOR 41 KG/M TO 60 KG/M RAILS
326-A2-84-1569	26/11/84	FISHPLATED JOINTS - FISHBOLT M24 X 115MM FISHBOLT WITH SQUARE NUT

NEW DRAWINGS TO BE PREPARED

7.7 JOINT ALIGNMENT

7.7.1 Misalignment limits

Table 7.3 shows the acceptable absolute limits and desirable construction limits for the misalignment of non-welded joints.

7.7.2 Absolute limits

The absolute limits defined in table 7.3 are not recommended for normal track, as their use may lead to severe problems with track geometry deterioration and high impacts causing component deterioration:

Table 7.3: Non-welded rail joint misalignment limits

Factor	Specification		Method of test	Corrective action
	Absolute limits	Desirable construction standards		
Peak in running surface			1 metre straightedge & feeler or taper gauge	
Dip in running surface			1 metre straightedge & feeler or taper gauge	
Gauge widening due to change in rail			1 metre straightedge & feeler or taper gauge	
Gauge narrowing due to change in rail			1 metre straightedge & feeler or taper gauge	
Vertical step in rail running surface			100mm straightedge & feeler or taper gauge	
Horizontal step in rail running surface			100mm straightedge & feeler or taper gauge	

*TO BE DEVELOPED **COMPARE TO TABLE 12.2***

8.0 MONITORING AND MAINTENANCE OF NON-WELDED RAIL JOINTS

8.1 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

a) This section prescribes the minimum requirements for inspection and response to non-welded rail joint conditions. For welded rail joints see section 6.

b) Known defects shall be positively identified in track with indelible marking.

c) Inspection, assessment and maintenance actions of non-welded rail joints shall include the specific conditions shown in table 8.1:

Table 8.1: Non-welded rail joint inspections, assessment and maintenance actions

Type of inspection or action	Specific conditions to look for or other actions
Scheduled inspections	
Walking inspections	a) Identify visually, and report, obvious rail defects and conditions (i.e. indicators of a defect) that may affect the integrity of the track structure including the following: 1) broken, missing or loose bolts; 2) broken plates; 3) metal flow across joints; 4) vertical deformation; 5) rail end batter; 6) insulation breakdown; 7) track circuit bond wire damage; 8) other obvious defects or missing components. b) Intervals between walking inspections shall not exceed 31 days.
Unscheduled inspections	To be undertaken when a joint is suspected to contain additional defects and is required to be kept in service.
Assessment and method of assessment	a) Detected defects in non-welded rail joints should be assessed and reported in accordance with the classification, position and sizing as specified in table 8.2. The actions for each defect and the response time to carry out such actions are also specified in the table. b) Free movement of sliding joints should be maintained. Where joints are frozen or poor joint regulation exists the track should be assessed in accordance with the recommendations in CP-TS-984 (Rail stress control). c) The definition of actions and response times are detailed in Appendices 1 and 2. For non-welded joints however, “repair or replace” should be interpreted to mean maintenance or reinstallation of the joint to the design specifications.
Maintenance actions and response	a) The actions for each defect and basic response time to carry out remedial action are detailed in Appendices 1 and 2. b) For non-welded joints the “repair or replace” action always implies maintenance or re-installation of the joint to the design specifications.

8.2 NON-WELDED JOINT ASSESSMENT

a) Free movement of sliding joints should be maintained. Where joints are frozen or poor joint regulation exists the track should be assessed in accordance with the recommendations in CP-TS-984 (Rail stress control).
b) Detected defects in non-welded rail joints should be assessed and reported in accordance with the classification, position and sizing as specified in table 8.2. the actions for each defect and the response time to carry out such actions are also specified in the table.
c) The definition of actions and response times are detailed in Appendix 1. For non-welded joints however, “repair or replace” should be interpreted to mean maintenance or reinstallation of the joint to the design specifications.

Table 8.2: Rail and non-welded joint assessment responses

DEFECT SIZE	RESPONSE TIME	ACTION
Fishplate cracks These are cracks or notches located in the area between the 3rd and 4th hole of a fishplate. Visual detection is possible by close examination of the fishplate for signs of cracks and bleeding. Detailed inspection can be carried out by using dye penetrant or similar		
Any visual cracks, 1 fishplate Bottom of fishplate Other positions on fishplate	 7 days 14 days	 Reassess or replace Reassess or replace
Any visual cracks, both fishplates	Immediately	To be assessed by a competent worker and trams to be stopped or piloted
Complete failure: 1 fishplate		
Complete failure: 1 fishplate and a visible crack in the other		
Complete failure: both fishplates		
Missing or ineffective bolts (6 bolt joint); ineffective bolts are those which have to be replaced as distinct from loose bolts.		
1 on each side ineffective	Routine maintenance	Replace any missing bolts
None, 1 or 2 on one side and 2 on the other side ineffective	1 day	Reassess or replace
3 on one side and none or 1 on the other side ineffective	Immediately	Assess, and/or apply clamps and apply a speed restriction depending on joint vertical support, longitudinal support and joint gap. May only be left overnight where vertical support is good and where longitudinal support is such as to prevent further significant gap opening. Where left overnight the speed must be limited to no more than 20km/h
3 on one side and 2 or 3 on the other side ineffective	Immediately	To be assessed by a competent worker, plates to be clamped and trams to be stopped or piloted.

Table 8.2 *(continued)*: Rail and non-welded joint assessment responses

DEFECT SIZE	RESPONSE TIME	ACTION
Loose fishbolts (6 bolt joint) In this defect, the bolts that are holding the joint together are not providing enough clamping force to the plates to ensure integrity of the joint. Excessive vertical or lateral movement of the joint occurs. In general, loose bolts shall be tightened. A loose fishbolt is one where the fishbolt nut provides some but not full compression of the spring washer. See also sub-section 8.3		
1 on each side loose	Routine maintenance	Tighten any loose bolts. See also sub-section 8.3
None or 1 on one side and 2 on the other side loose	14 days	Reassess, replace or tighten. See also sub-section 8.3
a) 2 on each side loose; or b) none or 1 on one side and 3 on the other side loose	3 days	
5 or 6 bolts loose (but with sufficient integrity to provide vertical and lateral support)	1 day	
All bolts loose, joint vertical and horizontal support lost	Immediately	Replace, tighten, apply clamps or assess and apply speed restriction depending on joint gap and on vertical support and lateral support from track structure. See also sub-section 8.3
Defects in electrical insulation (Insulated joints only)		
Any	Immediately	Check to identify any potential signalling problems and repair in accordance with specifications
End batter		
Rail end batter greater than 2mm measured over 100mm	Immediately	Check, assess or speed restrict as necessary
Joint gap defect Where joint gaps are identified as greater than the nominal maximum design gap the joint shall be inspected for fishplate and fishbolt defects and visible rail misalignment or defects. The joint gap may indicate stress control problems, which should be assessed in accordance with CP-TS-984 (Rail stress control).		
Joint gaps ≥ 15mm and < 20mm	Routine maintenance	Planned maintenance
Joint gaps ≥ 20mm and < 30mm	1 day	Check for fishplate and fishbolt defects (especially broken bolts), visible rail discontinuities and defects and stress control problems and take appropriate actions for defects found
Joint gaps ≥ 30mm	Immediately	Review risk of wheel climb (track curvature, horizontal angle at joint, degree of misalignment of joint, joint vertical and lateral integrity). Apply speed restriction or pilot
Rail defects		
Any	In accordance with section 6.0	In accordance with section 6.0.

Notes:

[1] "1 day" is to be taken to mean till the end of daylight hours on the next day.

[2] More stringent restrictions should be applied if vertical, lateral or longitudinal support conditions are poor.

[3] Any subsequent actions determined from an initial assessment should be carried out within a timescale consistent with the severity of the problem.

[4] Refer to monitoring and maintenance actions and response in CP-TS-973 (Infrastructure maintenance and principles).

8.3 SPRING WASHERS

Correct tension in fishbolts shall be indicated by the spring washer being fully compressed when the fish-nut is fully tightened. Whenever a fishbolt is un-done for whatever reason the spring washer is to be replaced with a new, unused spring washer to ensure that the correct bolt tension is obtained. ***TO BE REVIEWED***

9.0 RAIL WEAR

9.1 GENERAL

This section prescribes the minimum requirements for inspection and the response to the following rail wear conditions:

a) top wear;

b) side wear;

c) gauge face angle.

9.2 RAIL WEAR

There are generally two rail wear mechanisms, top wear where the rail head is worn down or ground down, and side wear where the rail wears from the gauge face. The allowable limits for top wear and side wear at which the capacity of the rail should be reviewed are given in sub-sections 9.3 and 9.4 respectively. Top wear is the dominant wear mechanism for low rails of curves, tangent tracks and curves of greater radius than 600m. Side wear is the dominant wear mechanism for the high rail of curves sharper than 600m radius.

9.3 TOP WEAR

Top wear can be measured by one of two methods:

a) determining the height of the rail in mm;

b) determining the loss of head area as a percentage of the original head area.

The rail top wear limits are shown in table 9.1:

Table 9.1: Rail top wear limits

Rail type	New rail head area mm²	New rail height mm	Loss of head area limit %	Loss of height limit mm	Worn height limit mm
80A	2 135	127	30	10	117
80AS	2 116	133	30	11	122
AS 41kg	2 148	136.5	30	11	125.5
AS 47kg	2 548	141	40	13	128

Notes to table 9.1:

[1] The rail top wear limit is the worst case of either loss of height limit or loss of head area limit.

[2] Loss of head area limits are more critical for side wear. Where rails have more than 10mm of side wear, the loss of head area limit given in table 9.2 is to be used in the assessment of top wear limit

[3] The limits apply to the worst location, and not the average rail wear, for the segment of track being considered (such as a curve).

[4] The limits do not apply to combination of defects, see CP-TS-973 (Infrastructure management and principles). Where combined defects occur assessment should be by a competent worker.

[5] When approaching the rail wear limits, factors such as defect types, defect density and defect history should be considered.

9.4 SIDE WEAR

Side wear can be measured by one of two methods:

a) determining the width of the rail 8mm below the running surface;

b) determining the loss of head area as a percentage.

The rail side wear limits are shown in table 9.2:

Table 9.2: Rail side wear limits

Rail type	New rail head area mm²	New rail head width mm	Loss of head area limit %	Loss of head width limit mm	Worn head width limit mm
80A	2 135	63.5	25	20	43.5
80AS	2 116	70	25	24	46
AS 41kg (82lb)	2 148	63.5	25	20	43.5
AS 47kg (94lb)	2 548	70	34	24	46

Notes to table 9.2:

[1] The rail side wear limit is the worst case of either loss of width limit or loss of head area limit.

[2] The limits apply to the worst location, and not the average rail wear, for the segment of track being considered (such as a curve).

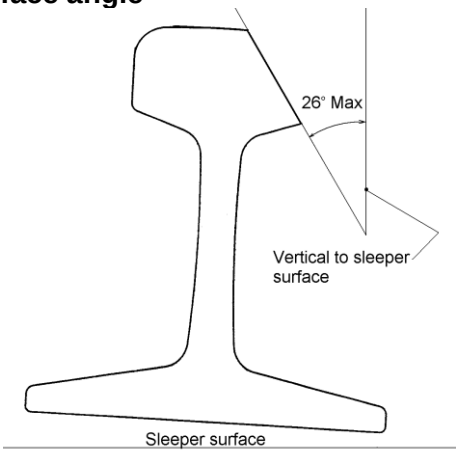
[3] The limits do not apply to combination of defects, see CP-TS-973 (Infrastructure management and principles). Where combined defects occur assessment should be by a competent worker.

[4] When approaching the rail wear limits, factors such as defect types, defect density and defect history should be considered.

9.5 GAUGE FACE ANGLE

In order to prevent wheel flange climbing in the presence of a high lateral to vertical (L/V) wheel/rail force ratio, particularly in very tight radius curves, limits are set for the allowable angle on the gauge face of the rail. The gauge face angle of rails should not exceed 26 degrees from vertical over a length of rail of more than 2m. The gauge face angle is measured as the angle between a line perpendicular to the sleeper plane (ie. the plane of the track) and the line tangential to the rail gauge face where wheel flange contact occurs.

Diagram 9.1: Gauge face angle



10.0 MONITORING AND MAINTENANCE OF RAIL WEAR

10.1 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

Inspection, assessment and maintenance actions for rail wear shall include the specific conditions shown in table 10.1:

Table 10.1: Rail wear inspections, assessment and maintenance actions

Type of inspection or action	Specific conditions to look for or other actions
Scheduled inspections	
Walking inspections	a) Identify visually, and report, rail wear defects and conditions (i.e. indicators of a defect) that may affect the integrity of the track structure including the following: 1) high levels of rail wear approaching wear limits, particularly on curves (e.g. presence of steel filings); 2) excessive rail gauge face angle; 3) other unusual and obvious wear patterns and defects indicating, for example, poor vehicle tracking, sharp points in curves or excess/deficient cant. b) Intervals between walking inspections shall not exceed 31 days.
Detailed inspections	Detailed inspections: a) may be carried out following a walking inspection, which identifies sections of track suspected to have head wear near the wear limit. b) shall be carried out every 24 months except as provided for in (a). c) shall include measuring the amount of head wear of rails particularly on curves and the gauge face angle.
Unscheduled inspections	To be undertaken if a worn rail breaks or fails, particularly if this results in a derailment or other incident.
Assessment and method of assessment	a) Rail wear and gauge face angle defects should be reported and action taken when any of the wear limits prescribed are exceeded. Rail wear should be assessed against the limits prescribed in section 9.0. b) Where the prescribed wear limits are exceeded a rating of the rail may be carried out taking into account local factors and applied speed restrictions. Alternatively, the action should be to re-rail the affected section.
Maintenance actions and response	a) Where the prescribed gauge face angle limits are exceeded the required action is to reinstate an acceptable rail gauge angle (e.g. re-profile in accordance with sub-section 9.5 and 10.2) or re-rail the affected section. b) Where the prescribed rail wear limits are exceeded the required action is to re-rail the affected section. See sub-section 10.2.

10.2 TESTING FOR RAIL WEAR

Rail testing shall be carried out in accordance with the procedure shown in figure 10.1 and table 10.2. For values of A, B, C and D refer to table 10.2.

Figure 10.1: Procedure for measuring rail wear:

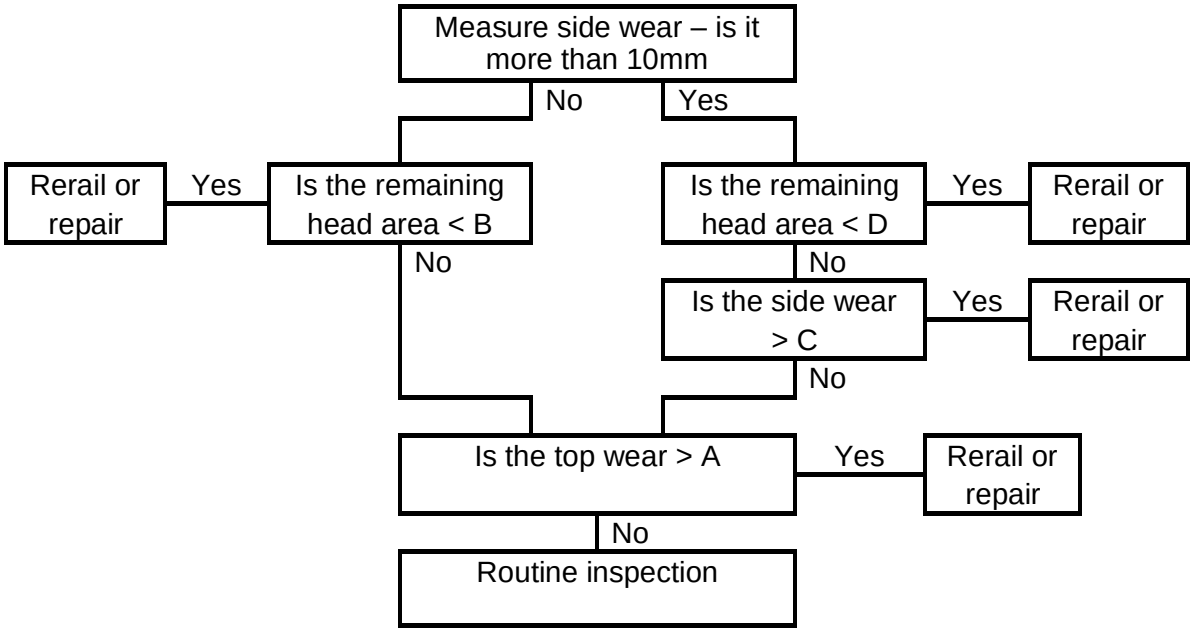


Table 10.2: Limits of wear:

Rail Type	A Top wear	B Remaining head area	C Side wear	D Remaining head area
80A	10mm	1495 mm²	20mm	1601 mm²
80AS	11mm	1481 mm²	24mm	1587 mm²
AS 41kg	11mm	1504 mm²	20mm	1611 mm²
AS 47kg	13mm	1529 mm²	24mm	1682 mm²

10.3 RAIL PROFILE

Where rail grinding to achieve a desired cross-sectional profile is undertaken, the profiles shall be determined.

11.0 REPAIR OF DEFECTIVE RAILS AND WELDS

11.1 GENERAL

This section prescribes the welding, materials and processes for repair of the running surface of rails in or out of track. This includes repair welding to damaged rails, V-crossings, building up of battered rail ends and wheel burns. It does not include rail joining processes.

11.2 ACCEPTABLE WELDING PROCESSES

The repair welding of the rail running surface, including the building up of worn cast manganese steel V or K crossings, may be carried out using manual metal arc and MIG repair welding - see sub-sections 8.4 and 8.5.

Repair of defective rails and welds should be carried out in accordance with Appendices 1 and 2. When a defect is to be removed, consideration should be given to removal of any other identified rail and weld defects in the vicinity.

11.3 OTHER WELDING METHODS

Other welding methods may be used but shall be subject to a stringent validation process that shall include metallurgical, physical and extensive field testing.

11.4 MANUAL METAL ARC AND MIG REPAIR WELDING

Manual metal arc and MIG repair welding, including materials, process and post weld testing shall be carried out in accordance with table 5.3

11.5 RAIL SURFACE REPAIR WELD PROCESS

A schedule of the different types of rail defect with the inspection requirements, response times and necessary action is shown in Appendices 1 and 2. Note: All repairs should meet the rail surface requirements of section 12.0 (Discontinuities).

12.0 RAIL DISCONTINUITIES IN WELDED RAILS

12.1 CONSTRUCTION LIMITS

The construction limits for the control of rail running surface discontinuities during the following processes are given in table 12.1.

a) laying of rail in track;

b) production of rail lengths for installation;

c) insertion of rail welds into track including those for closure rails.

The test measurements should be assessed against the construction standard specifications and appropriate action prior to opening the track for normal traffic. Internal rail defects arising from construction are covered in section 6.0.

Table 12.1: Welded rail discontinuities (new welds) [see note 1]

FACTOR	ABSOLUTE LIMITS	DESIRABLE CONSTRUCTION LIMITS	METHOD OF TEST	CORRECTIVE ACTION
Peak in running surface	+0.5mm over 1m	+0.0mm to +0.3mm over 1m.	1m reference and height difference measure [see note 2]	Remove or grind
Dip in running surface	-0.5mm over 1m	Nil	1m reference and height difference measure	Remove or lift
Gauge widening due to change in rail	0.5mm over 1m	0.5mm over 1m	1m reference and height difference measure	Remove or bend
Gauge narrowing due to change in rail	0.5mm over 1m	0.5mm over 1m	1m reference and height difference measure	Remove or grind
Vertical step in rail running surface	±0.3mm over 100mm	±0.15mm over 100mm	100mm reference and height difference measure	Remove or grind
Horizontal step in rail running surface	±0.3mm over 100mm	±0.15mm over 100mm	100mm reference and height difference measure	Remove or grind

Notes:

[1] Requirements for rail with non-welded rail joints are to be determined (see table 7.3).

[2] For example a 1m straight edge and feeler or taper gauge.

[3] Tolerances are only applied to areas of the rail where wheel contact may occur.

12.2 RAIL DISCONTINUITIES ASSESSMENT

The assessment of discontinuities in rails should incorporate the measures in clauses 12.2.1 and 12.2.2.

12.2.1 Running surface discontinuities in welded rails

This clause gives limits for the control of rail running surface discontinuities identified from track inspection. The limits given are recommended limits only for existing track and are not recommended for normal track construction and maintenance work (refer to sub-section 12.1). The limits are not intended to indicate best practice as discontinuities of the magnitude defined in table 12.2 may lead to a need for a significantly higher maintenance input than track with good geometry. Where discontinuities of these magnitudes are left in track, problems with track geometry deterioration and high impact, causing ballast and track component deterioration, can be expected. The detection of these types of defects during inspection will generally be through identification of these secondary effects. In some modes of track deterioration, timber sleepered track has a better inherent ability to tolerate impacts resulting in a lower rate of deterioration than for concreted track.

Table 12.2: Welded rail discontinuities (maintenance) assessment

FACTOR	LIMIT	METHOD OF TEST	CORRECTIVE ACTION
Peak in running surface	2mm over 1m	1m reference and height difference [see note 2]	Remove or grind
Dip in running surface	2mm over 1m	1m reference and height difference	Remove or lift
Gauge widening due to change in rail	2mm over 1m	1m reference and height difference	Remove or bend
Gauge narrowing due to change in rail	2mm over 1m	1m reference and height difference	Remove or grind
Vertical step in rail running surface	2mm over 100mm	100mm reference and height difference	Remove or grind
Horizontal step in rail running surface	2mm over 100mm	100mm reference and height difference	Remove or grind

Notes:
[1] Method of testing for rail with non-welded rail joints is not specified.
[2] For example a 1 metre straightedge and feeler or taper gauge.

12.2.2 Gaps in the running rail

Refer to Appendix 2, sub-section A2.29

13.0 RAIL LUBRICATION/FRICTION MODIFIERS

13.1 INSTALLATION

Rail-mounted lubricators shall be installed and serviced in accordance with the manufacturer's specification.

13.2 OPERATION

The application of the lubricant/friction modifier shall be regulated to avoid:

a) contamination of the running surface because of excess quantities;

b) inadequate lubrication, which may be manifested by the appearance of steel particles on the ballast.

13.3 INSPECTION, ASSESSMENT AND MAINTENANCE ACTIONS

Inspection, assessment and maintenance actions of rail-mounted lubricators shall include the specific conditions shown in table 13.1:

Table 13.1: Rail lubricators inspections, assessment and maintenance actions

Type of inspection or action	Specific conditions to look for or other actions
Scheduled inspections	
Walking inspections	a) Identify visually, and report, obvious lubricator ineffectiveness or unusual conditions resulting from rail lubrication or friction modification. b) Intervals between walking inspections shall not exceed 31 days.
General inspections and servicing	a) Identify conditions which may contribute to undesirable traction/braking problems or rail/wheel wear. Check that operation is in accordance with sub-section 13.1 and that lubricator is working. b) To be scheduled at intervals appropriate to each location, dependent on its nature, condition and other seasonal factors but not to exceed 3 months.
Unscheduled inspections	To be undertaken following the report of: a) excessive lubricant causing traction adhesion difficulty; or b) inadequate lubrication causing rail wear particles to show up on the ballast.
Assessment and method of assessment and maintenance actions	Undesirable conditions including those referred to in unscheduled inspections shall be assessed, reported and appropriate actions taken.

13.4 LUBRICATOR ASSESSMENT

In order to determine the most appropriate action, ineffective lubrication can be detected or measured by:

a) visual Inspection;

b) tribometer;

c) gauge (Goop Gauge);

d) reported train handling anomalies.

14.0 DOCUMENTATION

14.1 RAIL DEFECTS

Inspection reports shall be maintained in accordance with table 6.1 and CPRD/PRC/046 Records Management of:

a) defect listing and status;

b) defective rail/welds;

c) defect removal.

14.2 ULTRASONIC RAIL TESTING

Inspection reports shall be maintained for ultrasonic rail testing in accordance with QP-IS-002 (Developing Process Documentation).

14.3 RAIL WEAR

Inspection reports shall be maintained of rail with top wear greater than 20%, and side wear greater than 15% in accordance with CPRD/PRC/046 Records Management.

14.4 ALUMINOTHERMIC WELDS

Records shall be maintained of all aluminothermic welds including batch numbers in accordance with QP-IS-501(Document and Data Control).

14.5 RAIL WEIGHTS IN TRACK

The Track Configuration Record to be maintained in accordance with CP-TS-980 (Track support systems) shall also record rail weights in track. ***RECORD TO BE PREPARED***

14.6 INSULATED JOINTS

Records shall be maintained of all insulated joints in accordance with QP-IS-501(Document and Data Control). ***RECORD TO BE PREPARED***

14.7 RAIL LUBRICATION

A schedule of where rail lubricators are located shall be maintained in accordance with QP-IS-501 (Document and Data Control). ***SCHEDULE TO BE PREPARED***

A1.0 APPENDIX 1: RAIL DEFECTS - TYPES, POSITIONS AND SIZING

A1.1 DEFECT TYPE CODES AS USED IN APPENDIX 2:

Table A1.1: Defect type codes

Appendix 2, section:-	Defect type	Defect code
A2.1	Shatter cracks	SC
A2.2	Transverse defect	TD
A2.3	Transverse defects multiple	TM
A2.4	Transverse defect from wheel burn	TW
A2.5	Transverse defect from shelling	TS
A2.6	Shelling rail	SH
A2.7	Horizontal split (head)	HS
A2.8	Horizontal split (web)	HS
A2.9	Vertical split (head)	VS
A2.10	Vertical split (web)	VS
A2.11	Piped rail	PR
A2.12	Transverse split	TS
A2.13	Head web separation	HW
A2.14	Foot web separation	FW
A2.15	Bolt hole crack	BC
A2.16	Bolt hole elongation	BE
A2.17	Bolt hole non-conforming	BN
A2.18	Weld defect (head)	WA, WF, WT [1]
A2.19	Weld defect (web)	WA, WF ,WT [1]
A2.20	Weld defect (foot)	WA, WF, WT [1]
A2.21	Weld defect: repairs of surface defects	WR
A2.22	Mill defect	MD
A2.23	Corroded rail	CR
A2.24	Mechanical joint	MJ
A2.25	Rail surface condition	RS
A2.26	Wheel burn	WB
A2.27	Notches	NO
A2.28	Broken foot	BF
A2.29	Broken rail	BR
A2.30	Oxy-cut rail	OC
A2.31	Underlength rails	UR
A2.32	Unclassified defect	

[1] Weld defects: WA = Aluminothermic weld; WF = Flash butt weld; WA = Arc weld.

A1.2 DEFECT POSITION CODES USED IN APPENDIX 2:

Table A1.2: Defect position codes

Position in rail	Head	Web	Foot (flange)	Head + Web	Web + Foot	All
Code	H	W	F	X	Y	Z

A1.3 SIZING OF DEFECTS IN APPENDIX 2:

a) Transverse defects are recorded as a height measurement or as a percentage of head area. It is assumed in Appendix 2 that defects measured in mm are approximately circular to give a conversion to percentage.

b) Longitudinal defects are recorded as a length.

A1.4 RESPONSE TIME DEFINITIONS

Table A1.3: Response time definitions

Response time	Definition
Immediate	To be carried out prior to the next tram.
Specified in days (e.g. 30 days)	The specified period within which action shall occur.

A1.5 ACTION DEFINITIONS

Table A1.4: Action definitions

Action	Definition
No action	No action is to be taken and the defect need not be recorded.
Observe	The defect shall be visually inspected at intervals not greater than 90 days for any appearance of visual defects (for example discolouration, red or purple oxidation around the crack, also called bleeding, or surface cracking). An ultrasonic inspection shall be carried out every 12 months.
Re-assess	Repeat original assessment process, and carry out actions as required.
Speed restrict	Reduce tram speed to no more than 30 km/h to limit consequences of failure, when specified: a) as an action in the rail and rail weld defects in Appendix 2; or b) when applied to compensate for actions or re-assessment not being undertaken. Speed restrictions at speeds higher than 30 km/h may be specified provided suitable actions to limit defect growth is undertaken during the response period.
Repair	The defect is to be repaired.
Plate	The defect is to be fishplated to standards in accordance with section 4 with respect to temporary joints. Any plated defect must be treated as a temporary joint and monitored in accordance with inspection of non-welded rail joints (section 6). A defect that has been plated and subsequently breaks shall be treated as a broken rail and replated or removed as required.
Remove	The defect is to be removed or the rail replaced.
Replace (for fishplates)	The defective fishplate is to be replaced.
Pilot	Each tram operation shall be visually supervised and piloted over the defective rail or track. [see definition of “pilot” in CP-TS-972 (Structure and application)].

Note:

[1] Time periods used in Appendix 2 are based on the assessment of the rate of propagation of rail defects. Where a defect cannot be actioned in accordance with the table an assessment of track condition is to be undertaken. This should be based on the severity of the defect, the time to planned repair completion, whether and under what circumstances trams can operate over the defect and what arrangements for regular retesting and increased surveillance are to be made.

[2] All repairs should meet the rail surface requirements of section 12.0 (Discontinuities)

A2.0 APPENDIX 2: RAIL DEFECT CATALOGUE

A2.1 SHATTER CRACKS; Defect code: SC; Defect position: H

This is a series of closely spaced internal defects that occurs within the head of rail.

The origins of this defect are small hydrogen inclusions or cracks in the head of a rail. This defect is likely to be extant throughout the length of the rail. Shatter Cracks are likely to progress to Transverse Defects.

Action shall be taken by replacing the complete rail between welds, unless the rail has been inspected in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
Less than 5% (i.e. 10mm)	90 days	Re-assess or remove
Greater than 5%(i.e. 10mm)	Treat as Multiple Transverse defect (TM)	

A2.2 TRANSVERSE DEFECT; Defect code: TD; Defect position: H

This is a single isolated transverse internal defect that occurs within the head of the rail. The remaining rail length between adjacent welds shall be checked ultrasonically for other Transverse Defects. If these are present then the defect shall be treated as a Multiple Transverse Defect (TM).

The origin of this defect is an imperfection in the steel, for example a shatter crack, minute inclusion or an internal longitudinal seam or segregation. Impact of the wheels and bending stresses start the growth of a transverse separation around the imperfection.

Visual detection is only possible after the defect has reached the surface. Rail breakage almost always occurs before the defect becomes visible.

Action shall be taken by removing the defect and restoring the rail by welding. Any rail removed from track shall be quarantined to control its future use.

Defect size	Response time	Action
Less than 5% (i.e. 10mm)	None	No action
5-10% (10-20mm)	7 days	Re-assess or plate or remove
10-30% (20-30mm)	1 day	Speed restrict and re-assess, or plate or remove
Greater than 30% (i.e. > 30mm)	2 hours	Pilot or plate or remove
Greater than 30% and surface cracking on rail head	Immediate	Pilot or plate or remove
Broken rail (ref BR defect)	Immediate	Pilot or plate or remove

A2.3 TRANSVERSE DEFECTS MULTIPLE; Defect code: TM; Defect position: H

Multiple Transverse Defect is where there is more than one Transverse Defect in the same rail. Refer to Transverse Defect for descriptions, origins, manner of propagation, visual detection information and failure mode information.

Action shall be taken by replacing the complete rail between welds, unless the rail has been inspected in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
Less than 5% (i.e. 10mm)	None	No action
5-10% (10-20mm)	7 days	Re-assess or remove
10-30% (20-30mm)	1 day	Speed restrict and re-assess every day or remove
Greater than 30% (i.e. > 30mm)	Immediate	Pilot or remove
Greater than 30% and surface cracking on rail head	Immediate	Pilot or remove

A2.4 TRANSVERSE DEFECT FROM WHEEL BURN; Defect code: TW; Defect position: H

Transverse defect propagated from a wheel burn. A slipping wheel heats the rail surface and may flow the metal. Rapid cooling forms thermal cracks and wheel pounding starts horizontal separations. Visual detection is usually not possible due to masking by the wheel burn. Small wheel burns may be ground out. The defect should be removed and the rail restored by welding. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
All sizes	Treat as TD or TM as appropriate	

A2.5 TRANSVERSE DEFECT FROM SHELLING; Defect code: TS; Defect position: H

This defect originates below the rail surface usually at the gauge corner on high legs of curves. This defect can mask a transverse defect that grows into the rail head. The origins of this defect are high stresses below the rail surface that grow from an imperfection in the steel, for example a minute inclusion. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
All sizes	Treat as TD or TM as appropriate	

A2.6 SHELLING RAIL; Defect code: SH; Defect position: H

This is a rolling contact rail fatigue defect initiated at the wheel/rail contact surface and is the result of high rail stresses below the rail surface. The defect is visible as running surface cracks usually with a black central area. They often are caused by large non-metallic oxide inclusions just below the running surface at the gauge corner. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
All sizes	Treat as TD or TM as appropriate	

A2.7 HORIZONTAL SPLIT (Head); Defect code: HS; Defect position: H

This is an internal defect that occurs within the head of rail. It is a progressive longitudinal fracture in the rail, where separation along a seam spreads horizontally through the head, parallel to the running surface. It may curve upward or downward before breaking. The origin of this defect is an internal longitudinal seam, segregation, or inclusion. This may be seen generally by a widening in the top of the rail head. A horizontal crack will eventually start to form on the sides of the rail head. This defect can result in a long section of the rail head falling out and can occur throughout the rail and therefore result in multiple breaks.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Defect size	Response time	Action
Less than 25mm		Observe
25 -100mm	35 days	Re-assess or remove
100 -200mm	7 days	Re-assess or remove
Greater than 200mm and possibly with severe bleeding or head flow	Immediate	Speed restrict and visually inspect every day or remove
Broken Rail (refer BR defect)	Immediate	Pilot or remove

A2.8 HORIZONTAL SPLIT (Web); Defect code: HS; Defect position: W

This is a defect that occurs within the web of the rail and may start from a weld. As it grows it may curve downwards or upwards or simultaneously in both directions. This defect is fast growing and may result in long sections of rail head and web falling out.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Visual inspection is by a horizontal crack forming on the sides of the rail web which can be seen by rust marks.

Defect size	Response time	Action
Less than 40mm	7 days	Re-assess or remove
40 - 75mm	2 days	Speed restrict or remove
Greater than 75mm	Immediate	Pilot or remove
Broken Rail	Immediate	Pilot or remove

A2.9 VERTICAL SPLIT (Head); Defect code: VS; Defect position: H

This is an internal defect that occurs within the head of rail. It is a progressive vertical fracture in the rail, where separation along a seam spreads vertically through the head, parallel to the side of the rail.

This is a serious defect because it can:

a) result in a long section of the rail head falling out;

b) occur throughout the remainder of the rail and thus result in multiple breaks.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Visual detection is by seeing a widening in the top of the rail head, or the dropping of one side of the rail head.

Defect length	Response time	Action
Less than 25mm		Observe
25 - 200mm	35 days	Re-assess or remove
200mm – 400mm	7 days	Re-assess or remove
Greater than 400mm	Immediate	Speed restrict and visually inspect every day, or remove
Broken Rail	Immediate	Pilot or remove

Note: If severe bleeding or cracked out increase by one defect size.

A2.10 VERTICAL SPLIT (Web); Defect code: VS; Defect position: W

This is an internal defect that occurs within the web of the rail. It is a progressive vertical fracture in the rail, where separation along a seam spreads vertically through the web, parallel to the web of the rail. In itself a VS is not a serious defect, however it may develop into a serious defect, for example Piped Rail or Horizontal Split Web. It can occur throughout the rail.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail shall be immediately rendered unsuitable for reuse.

Defect length	Response time	Action
All sizes	180 days	Re-assess (check for Piped Rail and Transverse or Horizontal Split Web) or remove

A2.11 PIPED RAIL; Defect code: PR; Defect position: W

This is a longitudinal internal defect that occurs within the web of the rail. The development of a vertical spilt web due to heavy loads can lead to an opening of a cavity and a bulge in the web. The pipe may originate from a mill defect and may contain inclusions. Shallow cracks due to distortion may be found in the bulging surface, and a slight depression above the pipe. Cracking can also develop at the edge of the bulge. Upon service failure the rail may break into several pieces.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse.

Defect length	Response time	Action
Less than 25mm	None	No action
25 – 150mm	35 days	Re-assess or remove
150 - 300mm	7 days	Re-assess or remove
Greater than 300mm	Immediate	Speed restrict and re-assess every day, or remove
Visible cracking	Immediate	Speed restrict and re-assess every day, or remove
Broken Rail	Immediate	Pilot or remove

A2.12 TRANSVERSE SPLIT; Defect code: TS; Defect position: W

This is an internal defect that occurs within the web of the rail. Origin is most commonly due to damage of the web.

Generally the defect is visually detectable.

Defect length	Response time	Action
Less than 20mm	None	No action
20 - 40mm	7 days	Re-assess, plate or remove
40 - 75mm	2 days	Re-assess, plate or remove
Greater than 75mm	Immediate	Speed restrict, plate or remove
Broken Rail	Immediate	Pilot or remove

A2.13 HEAD WEB SEPARATION; Defect code: HW; Defect position: X

This is a crack that generally occurs in the rail end and separates the head from the web. It starts developing parallel to the head/web fillet and may, as it develops, curve either upwards or downwards or simultaneously upwards and downwards. It is a progressive crack along the fillet.

This is a serious defect because it can:

a) result in a long section of the rail head falling out;

b) occur throughout the remainder of the rail and therefore result in multiple breaks.

Action shall be taken by replacing the complete rail between welds, unless the rail has been examined in detail by manual ultrasonic examination. The rail removed shall be immediately rendered unsuitable for reuse. Visual Inspection is by seeing a crack and rust running along the head/web fillet.

Defect length	Response time	Action
Less than 20mm	None	No action
20 -75mm	7 days	Re-assess or remove
75 - 200mm	2 days	Speed restrict and re-assess every day, or remove
Greater than 200mm	Immediate	Speed restrict and re-assess every day, or remove
Broken Rail	Immediate	Pilot or remove

A2.14 FOOT WEB SEPARATION; Defect code: FW; Defect position: Y

This is a crack that occurs in the foot and web fillet area. It is a progressive crack along the fillet.

Action shall be taken by replacing the complete rail between welds unless the rail has been examined in detail. The rail removed shall be immediately rendered unsuitable for reuse. Visual inspection is by seeing a crack running along the foot/web fillet.

Defect size	Response time	Action
Less than 20mm	None	No action
20-40mm	7 days	Re-assess or remove
40 -75mm	2 days	Speed restrict and re-assess every day, or remove
Greater than 75mm	Immediate	Speed restrict and re-assess every day, or remove
Broken Rail	Immediate	Pilot or remove

A2.15 BOLT HOLE CRACK; Defect code: BC; Defect position: W

A progressive fracture which originates at a bolt hole and progresses away from the hole usually at an angle. The origins are usually stresses along the edge of the hole from the bolt. The stresses may be the result of vertical or horizontal rail movement, improper drilling, a burr on the edge of the bolt hole or rolling stock impacts. Growth may be erratic and accelerated when subjected to additional stresses. Upon service failure the rail may break into several pieces.

As bolt holes are normally associated with fishplated joints, visual detection may only be possible after removal of plates. The crack may be accentuated by oxidation (bleeding). Defects should be cut out and replaced with a closure rail, the closure rail may be welded at both ends provided specified rail length limits are observed.

Defect length	Response time	Action
Less than 5mm	None	No action
5mm - 20mm	90 days	Re-assess
20 - 40mm	7 days	Re-assess or remove
40-75mm	2 days	Speed restrict and re-assess every day, or remove
Greater than 75mm	Immediate	Speed restrict and re-assess every day, or remove
Broken Rail	Immediate	Pilot or remove

A2.16 BOLT HOLE ELONGATION; Defect code: BE; Defect position: W

Mechanical compression or damage at a bolt hole arising from interaction with the bolt. The hole becomes oval with the resultant metal flow concentrating stress. This defect may progress to a bolt hole crack if at a rail end. A Horizontal Split Web may develop in a welded rail if the defect is not removed.

As bolt hole defects are normally associated with fishplated joints, visual detection may only be possible after removal of plates.

Defect size	Response time	Action
Any	None	No action

A2.17 BOLT HOLE NON-CONFORMING; Defect code: BN; Defect position: W

Any hole drilled in a rail web, which does not comply with specifications with respect to horizontal or vertical position, size, shape, condition or separating distance from other holes or rail end. This defect may result in additional stresses in bolt holes.

As bolt hole defects are normally associated with fishplated joints, visual detection may only be possible after removal of plates.

Defect size	Response time	Action
Any	None	No action

A2.18 WELD DEFECT (Head); Defect code: WA, WF, WT; Defect position: H

This is an internal defect that occurs within the head of the rail at welds joining rails. It usually starts from imperfections within the weld zone, for example lack of fusion or inclusions from the welding process.

Action shall be taken by removing the weld and then inserting a new section of rail or the use of a wide gap weld if no bolt holes exist. Visual detection is only possible after the defect has reached a surface.

Defect size	Response time	Action
Less than 5% (i.e. 10mm)	None	No action
5-10% (10-20mm)	7 days	Re-assess, plate, repair or remove
10-30% (20-30mm)	1 day	Re-assess, plate, repair or remove
30–70% (30–40mm)	2 hours	Speed restrict and re-assess every day, or plate, or remove
Greater than 70% (i.e. > 40mm)	Immediate	Speed restrict and re-assess every day, or plate, or remove
Surface Cracking [1] on rail head (visual - not confirmed by ultrasonics)	Immediate	Speed restrict and re-assess every day, or plate, or remove
Broken Weld	Immediate	Pilot, or plate, or remove

Note [1] Surface cracking may not be very deep but can only be confirmed by manual ultrasonics.

A2.19 WELD DEFECT (Web); Defect code: WA, WF, WT; Defect position: W

This is an internal defect that occurs within the web of the rail at welds joining rails. It usually starts from imperfections within the weld zone, for example lack of fusion or inclusions from the welding process.

Action shall be taken by removing the weld and then inserting a new section of rail or the use of a wide gap weld if no bolt holes exist. Visual detection is only possible after the defect has reached a surface.

Defect size	Response time	Action
Less than 25mm	None	No action
25-50mm	30 days	Re-assess, plate or remove
50-75mm	1 day	Speed restrict and re-assess daily, or plate, or remove
Greater than 75mm	2 hours	Speed restrict and re-assess daily, or plate, or remove
Broken Weld	Immediate	Pilot or plate or remove

A2.20 WELD DEFECT (Foot); Defect code: WA, WF, WT; Defect position: F

This is an internal defect that occurs within the foot of the rail at welds joining rails. It usually starts from imperfections within the weld zone, for example lack of fusion or inclusions from the welding process.

Action shall be taken by removing the weld and then inserting a new section of rail or the use of a wide gap weld if no bolt holes exist. Visual detection is only possible after the defect has reached a surface.

Defect size	Response time	Action
Less than 15mm width and full height of foot	14 days	Re-assess or plate or remove
15 - 35mm width (if on edge use 10 – 35mm)	1 day	Speed restrict and re-assess every day, or remove
Greater than 35mm width	Immediate	Speed restrict and re-assess every day, or remove
Broken Weld	Immediate	Pilot or plate or remove

A2.21 WELD DEFECT: REPAIRS OF SURFACE DEFECTS (surface e.g. gas hole, hot tear, shrinkage, porosity); Defect code: WR; Defect position: H

This is a defect in the head of the rail that results from an aluminothermic or arc weld repair. Ultrasonic defects that occur are to be found in other defect classifications. Alignment defects may be corrected by grinding, surface repair or replacement with a closure rail.

Alternatively, action shall be taken by removing the weld and then inserting a new section of rail or the use of a wide gap weld if no bolt holes exist. Visual detection is only possible after the defect has reached a surface.

Defect size	Response time	Action
Less than 3% (i.e. 10mm)	None	No action
3-7% (10-15mm)	7 days	Re-assess, plate, repair or remove
7-10% (15-20mm)	7 days	Re-assess, plate, repair or remove
10-20% (20-30mm)	1 day	Speed restrict, plate, repair or remove
Greater than 20% (i.e. > 30mm)	Immediate	Speed restrict, plate, repair or remove
Greater than 20% and surface cracking on rail head	Immediate	Speed restrict, plate, repair or remove
Broken Weld	Immediate	Pilot or plate, or remove

A2.22 MILL DEFECT; Defect code: MD; Defect position: Z

Deformations, cavities, seams or foreign material found in the head, web or foot of a rail. These defects are formed during manufacture. Further development depends on the type of defect, its position within the rail and loading of the rail. Surface defects may be visible but generally the defect is too small to be visible.

Action is not normally required until growth is detected, then the defect may be reclassified according to the nature of propagation or failure.

Defect size	Response time	Action
Any	None	The necessary action should be assessed by a competent worker

A2.23 CORRODED RAIL; Defect code: CR; Defect position: Y

Corrosion of the metal on the foot or web of the rail will result in pits or cavities. Corrosion occurs in wet or damp areas and is usually a slow process. However the process will be greatly accelerated in situations where electric current passes through the rail, or where chemicals, for example acidic ground water or fertilisers are concentrated. Points of high stress from corrosion pitting or severe reduction in cross section may cause sudden failure. Excavation of ballast, bitumen etc. may be required to view the corroded rail.

Action requires replacement of the defective portion of rail.

Note: The necessary action should be assessed by a competent worker and shall include consideration of the location, extent and geometry of the corrosion. Refer also to Rail Surface below where corrosion impacts on the running surface of the rail.

Defect size	Response time	Action
Greater than 3mm section loss in web or foot	7 days	Speed restrict until removed.

A2.24 MECHANICAL JOINT; Defect code: MJ; Defect position: X

This category refers to a rail where an unidentified ultrasonic response is received. Further information shall be provided to assist with visual inspection. The necessary repair should be determined by a competent worker.

Defect size	Response time	Action
Any	14 days	Remove plates and assess

A2.25 RAIL SURFACE; Defect code: RS; Defect position: H

This category refers to a rail surface condition, for example rolling contact fatigue, corrugation, checking and rust, which does not permit an adequate ultrasonic test.

Note: The necessary action should be assessed by a competent worker and include consideration of the location, extent and the ability to carry out ultrasonic testing of the rail affected.

Defect size	Response time	Action
Any	30 days	Assess

A2.26 WHEEL BURN; Defect code: WB; Defect position: H

A scar on the running surface of the rail caused by intense friction heating from slipping driving wheels. The flowed metal may chip out and thermal cracks may develop into a transverse defect.

Note [1] – Wheel burns should generally be removed by grinding and/or surface repair welding and in severe cases by removal of the rail and insertion of a closure rail. Grinding should remove all heat affected steel. Wheel burns can vary significantly in severity. The severity will determine the response time and action necessary. The geometry of the wheel burn can result in severe dynamic loading of the track and a resulting increased rate of deterioration of the track structure in general. Where defects are not removed from track, a defect management plan should be put in place to monitor the wheel burn for TWH defects and general track deterioration.

Defect size	Response time	Action
Any	See note [1]	Check for TWH

A2.27 NOTCHES; Defect code: NO; Defect position: Z

Mechanical damage to the head, web or foot of the rail, which results in a point of high stress. May be caused by hammer blows, equipment contact, damaged wheels, overdriven fastenings, local corrosion, wear from plates or fastenings, saw cutting or gas cutting. Defects are visible.

Action - Defects may be plated or cut out and the rail welded or replaced by a closure rail. The determination of the required action requires assessment of the defect by a competent worker and shall include consideration of the location, extent and geometry of the notch or cut. Isolated dented or bruised rail, for example due to a hammer blow, may not generally require removal.

Defect size	Response time	Action
Any	30 days	Assess

A2.28 BROKEN FOOT; Defect code: BF; Defect position: F

A progressive fracture in the foot of the rail with a vertical split. The separation is substantially longitudinal but usually turns out to the edge of the foot. These separations are often called half moon breaks. The cause is usually improper bearing on plates, damage to rail foot or a seam, segregation or inclusion. The crack is usually visible and may be accentuated by oxidation (bleeding).

Action - Defects may be cut out and replaced by a closure rail.

Defect size	Response time	Action
All	Immediate	Pilot or speed restrict and re-assess daily, plate, or remove

A2.29 BROKEN RAIL; Defect code: BR; Defect position: Z

This classification generally refers to a square or angular, sudden rupture, transverse separation of the head, web and foot of the rail. This type of failure usually occurs in very cold weather and is often caused by concentrated loadings (overstressing) from rolling stock or track maintenance operations. If any sign of a defect is present, the break shall be reclassified according to the type of defect.

Gap in the running rail - The following limits apply to the movement of traffic over a gap (or break) in the running rail:

Gap < 30mm	Operation of trams at a reduced speed appropriate to the assessed track conditions
Gap > 30mm and < 100mm	Pilot trams across gap
Gap > 100mm	Stop traffic

Assessment of the track condition by a competent worker should include consideration of the track alignment, sleepers, fastenings, track geometry and support either side of the gap (or break). The need for temporary plating of a gap (or break) should also be determined. In the case of a break, the nature of the rail break should be considered in the assessment. Note: imperfections that may have damaged rolling stock should be advised to the Traffic Control office.

Action - Defects may be plated or cut out and the rail welded (subject to compliance with minimum distance requirements to bolt holes) or replace by a closure rail.

Defect size	Response time	Action
All	Immediate	Pilot or speed restrict and plate or remove

A2.30 OXY- CUT RAIL OR BOLT HOLE; Defect code: OC; Defect position: Z or W

Rails and bolt holes that have been oxy-cut shall be considered as defective. They shall only be used in an emergency and shall be removed as soon as the emergency has passed.

Defect size	Response time	Action
Oxy-cut rails	Immediate	Speed restrict to 20km/hr and re-assess daily or remove
Oxy-cut bolt holes	Immediate	Speed restrict to 20km/hr and re-assess daily or remove

A2.31 UNDERLENGTH RAILS; Defect code: UR; Defect position: Z

Rails that are shorter than the minimum length shown in CP-TS-980 (Track support systems) for each configuration shall require the track at that location to be considered as conforming to the configuration to which the rail length corresponds. Where underlength rails are shorter than those corresponding to any track configuration they shall be considered as defective.

Defect size	Response time	Action
Length between the absolute minimum shown in table 2.1 and the length shown in CP-TS-980 (Track support systems)	90 days	Restore to standard configuration
Length less than the absolute limit shown in table 2.1	Immediate	Speed restrict to 30km/hr and restore to standard configuration within 90 days

A2.32 UNCLASSIFIED DEFECT;

The necessary repair should be determined by a competent worker.