BHP

Code of Practice - Track Maintenance

Standard

Document Number: 0002664
Version: 10.0

Document Control

APPROVER	DATE	DOCUMENT CUSTODIAN	REVIEW PERIOD
Manager GTS Mobile Rail & NPI (Rail Engineering)	February 2024	GTS Rail Track & Signals (Rail Engineering)	24 MONTHS

Table of Contents

List of Tables

List of Figures

Electronic Approval Record

Business Role	Name
Author Role	**Name**
Track Specialist - Rail Engineering	Geoff Layton
Reviewer Role	**Name**
Superintendent GTS Rail Track &Signals - Rail Engineering	Greg Crew
Approver Role	**Name**
Manager GTS Mobile Rail & NPI - Rail Engineering	Iain Gray

Document Amendment Record

Version. No	Page Number	Change Effected	Date of Change
7.0	ALL	Document Updated – New BHP Format	Sept 2018
8.0	ALL	Document Revision – TEI/TGI incorporated	Apr 2020
9.0	ALL	Document Revision – TEI/TGI incorporated/General Update	Nov 2021
10.0	ALL	Document Revision – TEI/TGI Incorporated/TCI banding Amended. Removed Reference to Rail Types	Feb 2024

Key Stakeholders

Department	Position
Rail Network Maintenance	Manager Rail Network Maintenance
Rail Network Maintenance	Superintendent Reliability
Rail Network Maintenance	Superintendent Condition Monitoring
Rail Network Maintenance	Superintendent Asset Integrity
Rail Network Maintenance	Superintendent Flashbutt Execution
Rail Network Maintenance	Superintendent Track Maintenance
Rail Safety Management Systems	Lead Safeworking

1. Purpose and Scope

1.1. Introduction

The purpose of this Code of Practice is to set out the Standards and Requirements to ensure the efficient operation and maintenance of the BHPIO owned and operated Railroad, including Mainline Track, Passing Tracks, Terminals and other ancillary Tracks.

The document covers:

1. Assets - Accepted types, handling, storage, reuse and disposal.
2. Inspections - Strategies for monitoring the BHPIO Railroad condition including type, content and frequency.
3. Defects - Allowable asset condition thresholds for application during inspections, including mitigating actions for threshold exceedances.
4. Maintenance Activities - Maintenance strategies including what maintenance shall be carried out based upon which triggers.

This Code of Practice recognises that the BHPIO Railroad is designed, constructed and operated for the purpose of supporting a mining operation, by transporting ore from the mines to a port. In this respect the purpose of the document is to support efficient and economical operation of the BHPIO Railroad. As such, thresholds and limits herein relate primarily to maintenance thresholds and limits considering inspection frequencies, deterioration rates and experience and are designed to minimise wear, extend component life and improve reliability, efficiency and serviceability.

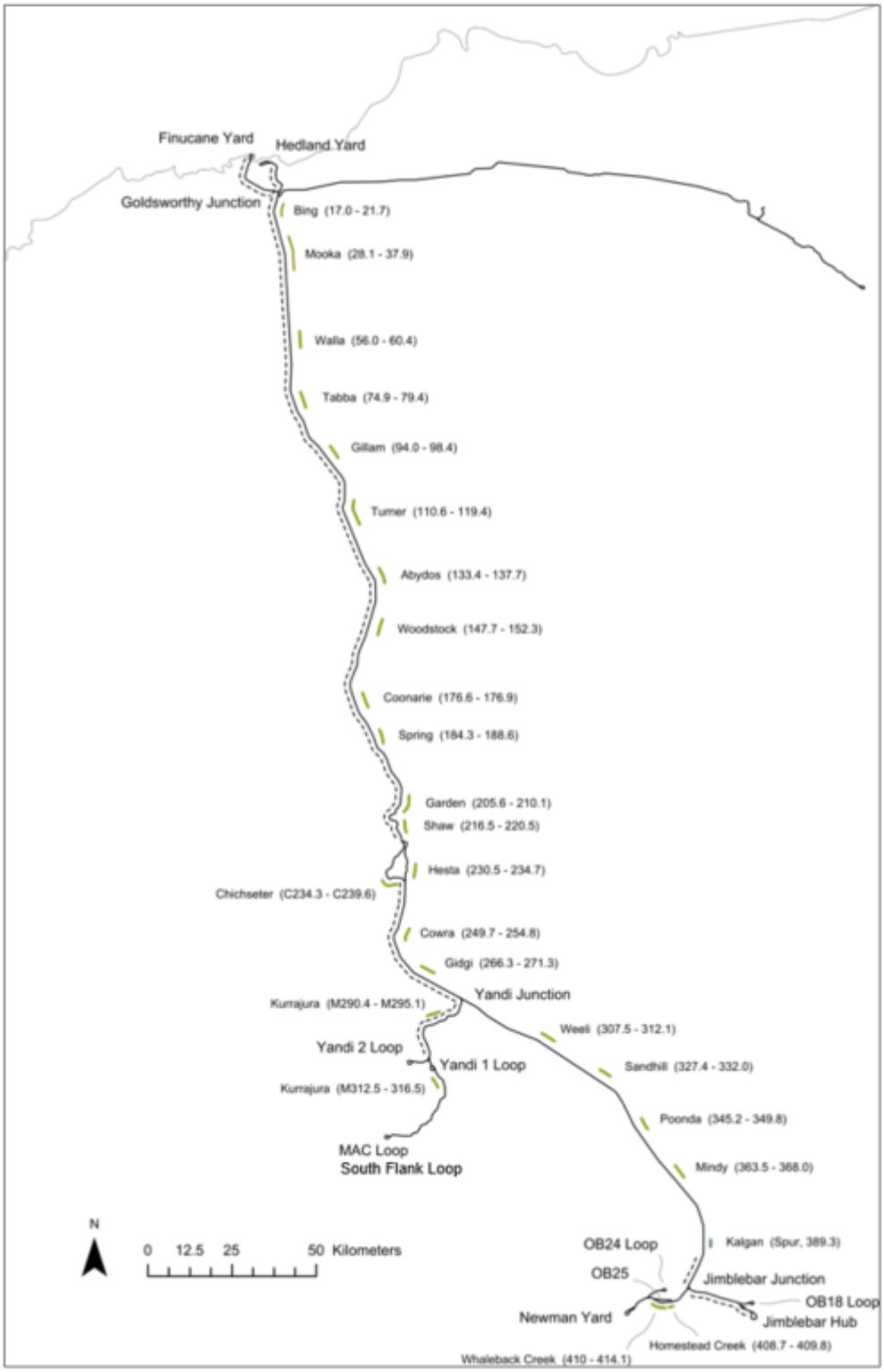
Content relating to the safe operation and maintenance of the BHPIO Railroad is also contained in the Rail Rule Book (RRB). In addition to the Rail Rule Book, this Code of Practice provides upper or lower limit thresholds with corresponding response codes for the purpose of safety and/or protecting the asset from terminal damage.

The contents of this Code of Practice are applicable for the maintenance of track for rail operations up to 40 Tonnes Axle Load with a total loading profile on the track of 395 Million Gross Tonnes Per Annum (equivalent to railing 290 Million tonnes of ore).

1.2. The BHPIO Railroad

This Code of Practice applies to the BHPIO Railroad network shown in the following map:

Figure 1-1 BHPIO Rail Network Map



1.2.1. Track Categories

The BHPIO Railroad has been categorised based on gross railed tonnage, line speed and performance requirements and comprises the following Track Categories:

Table 1-1 Track Categories

Track Types	Track Category 1	Track Category 2	Track Category 3	Track Category 4
Mainline Track	✓			Not Currently In Use
Passing Track		✓		
Back Track			✓	
Mine Balloon Loop		✓		
Hedland Yard Arrival Track		✓		
Hedland Yard Other Track			✓	
Newman Yard Arrival Track		✓		
Newman Yard Other Track			✓	
Mooka Staging Facility		✓		
Finucane Island Yard		✓		
Other Yard Tracks, Service Roads			✓	
Goldsworthy Line	Under Care and Maintenance			

1.2.2. Critical Assets

Irrespective of track category, the business should identify assets to be treated as Critical Assets, whose operability must be ensured to maintain the continual uninterrupted operation of the supply chain. These assets should be documented in a register and may require additional inspections and/or maintenance beyond that specified in this Code of Practice.

1.2.3. Track Naming

Track names are differentiated by use of the line reference which is unique for each route, e.g. Newman Mainline (NML), Mining Area C (MAC), Jimblebar (JBL), and each yard, e.g. Newman Yard (NY), Hedland Yard (HY). The track is then defined within the line by either type or orientation, separated in the reference code by a hyphen e.g. Newman Mainline West Track (NML-WT), Mining Area C East Track (MAC-ET), Jimblebar Single Track (JBL-ST).

In duplicated track areas, the track on the left when facing away from port is the East Track (ET) and the track on the right is the West Track (WT). In mainline areas with only one track the track is the Single Track (ST).

The rail on the left when facing away from Port (Direction of ascending Kilometres) is the East Rail (ER) and the rail on the right is the West Rail (WR).

Refer also to the BHPIO specification SPEC-000-R-00002.

1.2.4. Document Application

This Code of Practice is only for use by authorised staff and contractors of BHPIO in relation to the Railroad operations of the Company in the Pilbara.

This Code of Practice shall be kept confidential by such users and by anybody to whom it is submitted for accreditation purposes. No information relating to this document shall be divulged to any person at any time, except with prior consent of BHPIO.

This Code of Practice is copyright and no part of it shall be copied or reproduced for any purpose other than for the purpose of the Railroad operations of the Company in the Pilbara, nor shall it be published or used in relation to other railroads, except with prior written consent of BHPIO.

1.2.5. Document Update Procedure

This Code of Practice shall reside in a controlled document storage location, where it is available for general access, but locked against editing. At the time of writing, the designated system for this purpose is 1Doc Controlled Documents. Updates to this Code of Practice shall be controlled by Rail Engineering and approved by the Manager Rail Engineering.

Generally, content that relates to standards shall be set and validated by an independent engineer who is not associated with production delivery. Content that relates to maintenance activity shall be set and validated by the Manager of Rail Network Maintenance or a Superintendent of Rail Network Maintenance. Only suitably competent and authorised personnel may execute changes or addition to content.

Revisions of this Code of Practice will be published every twenty-four (24) months to incorporate additions and changes made as a result of:

- Changes in materials and equipment.
- Development and research.
- Findings following investigations into accidents and incidents.
- Changes in methodologies, operations and practices.

All technical changes are subject to risk assessment and the BHPIO Management of Change (MOC) process. MOC's shall be submitted by the change proposer with sufficient information to assist the Rail Engineering GTS Track department in reviewing the proposed change(s). The revision of this Code of Practice should be an output of this change process.

Formal audit of this Code of Practice shall have a defined period of not more than two years and the undertaking of this activity shall be the responsibility of the Superintendent GTS - Rail Engineering.

The Rail Safety National Law Act 2015 requires certain changes that are implemented on, or in relation to the BHPIO Railroad premises or rail operation be reported by the Safeworking Department to the Office of the National Rail Safety Regulator (ONRSR). Consult the Safeworking Department and refer to:

- Office of the National Rail Safety Regulator (ONRSR) procedure 0139628; and
- BHPIO Request for Submission of Change form 0139630 for further information.

Notifiable changes shall only come into effect after the 28-day notification period has elapsed.

This Code of Practice should be managed and controlled in compliance with the BHPIO Document control Specification. Document updates shall be made in the controlled document version following change approval process, and communicated to the document users by means of company approved alerts and notifications. Details of the update shall be recorded in the Document Amendment Record at the front of this Code of Practice, including section number and brief description of the change.

It is important to note that any changes made within this Code of Practice should be checked against other relevant documents listed within the Reference Document tables.

1.2.6. Document User Obligations

Users of this Code of Practice should ensure they are using the most recent version, as shown on the cover page and available within the 1Doc Controlled Documents system.

If a user of this Code of Practice becomes aware of circumstances where compliance with this document may compromise safety, they must contact his or her supervisor to resolve the immediate situation and report the circumstances to the Rail Engineering Manager.

A user of this Code of Practice, including any accreditation body, who finds any provision of the code:

- Unclear, out of date or in need of improved expression.
- Permits or requires some action which is or could be unsafe, unnecessary or inefficient.
- Factually incorrect.

Shall advise the Rail Engineering Manager of the details as soon as practicable.

1.2.7. Auditing

Auditing of compliance with this Code of Practice shall be carried out every two years as a minimum. The audit shall be carried out under the governance and guidance of the GTS Rail Engineering department and may include engagement of an independent third-party consultant.

The audit shall encompass the main elements of this Code of Practice with the objective of ensuring that the information presented is followed and appropriately executed.

All gaps identified will be presented to the relevant Rail Network Maintenance Superintendent(s) and or the Manager of Rail Network Maintenance for final approval and agreement of formalised actions to close the gaps. All identified gaps shall then be assigned deadlines and managed accordingly by the Rail Network Maintenance department and or relevant delegates until completion.

1.2.8. Document Interpretation

This code of practice is based on the experience, research and policies of BHPIO.
As such, any clarification of a meaning should be sought from BHPIO.

1.2.9. Management of CoP Non-compliance

All situations of CoP non-compliance shall require a waiver.

Non-compliances can arise as a result of many reasons, including but not limited to:

- Breakdown of inspection or maintenance plant and/or equipment.
- Track access not granted.
- Insufficient track time to complete task.
- Resource constraints; or
- System limitations such as inspections based on tonnes, on track where tonnes aren’t measured.

These issues can result in one or more of the following:

- Missed inspections.
- Overdue remedial timeframes.
- Planned maintenance activity timeframes not being met; and
- Maintenance tolerances not being met.

All non-compliances shall be subject to a risk assessment, completed by a competent person. Controls identified shall be endorsed and reviewed by the Risk Owner and Rail Engineering Manager, or their nominated delegates.

1.2.9.1. CoP Waiver

For all non-compliances to the Track Maintenance Code of Practice, it is mandated that all waiver requests are submitted via the online Management of Change System.

This control is implemented to ensure that any risks associated with the non-compliance are assessed and approved in a controlled and auditable manner to ensure safe operations.

The MoC shall outline the following as a minimum:

- Description of non-compliance.
- Why the non-compliance has occurred.
- Justification for the waiver; and
- Period for which the waiver is required.

The Change Initiator shall organise a risk assessment with all relevant stakeholders and outline the controls proposed to mitigate any risks associated with the non-compliance. Controls identified shall be reviewed and endorsed by a GTS Rail Engineering department nominee and approved by the Risk Owner and Rail Engineering Manager or their nominated delegates.

Subject to the outcome of the risk assessment, the Change Initiator shall raise the necessary notifications required to undertake remedial works and bring the asset back to compliance within the timeframe agreed to in the MoC.
In addition, the Change Initiator shall raise a separate notification to Rail Reliability to undertake an RCA and determine the root cause of the non-compliance.

The MOC shall comply with the BHPIO procedure Management of Change (SPR-IHS-SAF-028).

All COP waiver entries into the MOC system shall be prefixed with ‘COPW’. The MOC shall include all actions identified in the risk assessment, all 1SAP notification references and attach the approved risk assessment.

Importantly, waivers shall:

- Only come into effect once the MOC is endorsed and approved by area owner(s) and risk owner(s) or their nominated on-duty delegates.
- Have an agreed end date; and
- Not change any COP criteria.

1.2.10. Work Management and use of 1SAP

The approved Computer Maintenance Management System (CMMS) for the BHPIO Railroad is 1SAP.

1SAP shall be used to manage the preventative and corrective maintenance of the BHPIO Railroad assets and store history regarding the execution of this maintenance.

Where inspections or maintenance are required to occur on a set frequency 1SAP shall be utilised to automatically create Work Orders. The inspection or maintenance requirement, either as instructions or in checklist format (Preventative Maintenance Instruction (PMI)), shall be linked to the Work Order. A copy of both the Work Order and the PMI shall be carried with the person executing the task.

The completed PMI shall be scanned and attached to the Inspection Notification. Any defects detected during these inspections shall be raised as subsequent Notifications to the executed inspection notification and be raised against the specific affected assets.

Defects identified during ad-hoc inspections shall be raised as a new Notification against the specific asset which is defective.

Note that 1SAP manages the maintenance and records the maintenance history. Other systems such as the Track Condition Monitoring System (TCMS) are used to record reliability data such as that obtained from the Track Condition Monitoring Vehicle.

1.2.11. Reference Documents

1.2.11.1. 1DOC

The following documents can be found in 1DOC:

Document ID	Title / Description
Asset Management Managed Document AM0001317	Corrosion Classification and Treatment
Asset Management Managed Document AM0106047	Structural Integrity Management E-Room Structure
Asset Management Managed Document AM0106052	Structural Integrity Completing Inspection Records Using the Structural Defect Register Spreadsheet
Asset Management Managed Document AM0106053	Structural Integrity Inspection Review Using the Structural Defect Register Spreadsheet

1.2.11.2. Controlled Documents

The documents below can be found in the Controlled Documents section of the Iron Ore portal.

Document ID	Title / Description
CD - 0118073	Train Control Asset Protection Systems
CD - 0168096	RRB RULE GR01 Rail Network Safety.
CD - 0168104	RRB RULE RT01 Preparation and Movement of Rail Traffic
CD - 0168126	RRB RULE WT01 Planning Work in the Rail Network
CD - 0168172	RRB MANUAL RTM04 Work Trains
CD - 0168180	RRB MANUAL NSSM Network Signals and Signs Manual
CD - 0121599	WAIO Extreme Weather Procedure
SPR-IHS-SAF-071	Hot Works Procedure
SPR-RTS-GEN-001	Broken Rail Procedure
Standard – 0018959	Structural Integrity Management Standard
WIN - 0076715	Work Instruction - 5 Year Structural Inspection of a Culvert
WIN - 0106592	Work Instruction - Ballast Deck Bridge Inspections
WIN - 0071998	Work Instruction - Stat Insp Signage
WIN - 0076696	Work Instruction - 1Y Safety Certify Rail Bridge
WIN - 0076701	Work Instruction - Installation MSA Rail Slider WAH
WIN - 0076702	Work Instruction - 1Y Mech Insp Bridge Transom
WIN - 0076703	Work Instruction - 1Y Mech Insp Bridge Ballast

Document ID	Title / Description
WIN - 0076704	Work Instruction - 1Y Mech Service Bridge Transom
WIN - 0076705	Work Instruction - 1Y Mech Service Bridge Ballast
WIN - 0076706	Work Instruction - 1Y Mech Insp Bridge Transom WAH
WIN - 0076709	Work Instruction - Verify Cmon Bridge Type A WAH
WIN - 0076710	Work Instruction - Verify Cmon Bridge Type A
WIN - 0076714	Work Instruction - 1 Year Mechanical Service of a Culvert
WIN - 0076717	Work Instruction - Verify Cmon Bridge Type D WAH
WIN - 0076718	Work Instruction - Verify Cmon Bridge Type D
WIN - 0076720	Work Instruction - Culvert Service
WIN - 0078027	Work Instruction - Excavator Operation of
WIN - 0087638	Work Instruction - Box Turnout Ballast (Manual)
WIN - 0087639	Work Instruction - Grind & Service Turnout SNX
WIN - 0087640	Work Instruction - Replace Turnout Closure Rail
WIN - 0087641	Work Instruction - Grind & Service Turnout RBM
WIN - 0087643	Work Instruction - Replace Turnout Insulated Rail Joint (Glued)
WIN - 0087648	Work Instruction - Tamp Turnout Bearers (Manual)
WIN - 0087649	Work Instruction - Lube & Service Turnout SNX
WIN - 0087651	Work Instruction - Replace Turnout Rollers
WIN - 0087652	Work Instruction - Replace Turnout Spreader Bar
WIN - 0087653	Work Instruction - Lube & Service Turnout RBM
WIN - 0087655	Work Instruction - Adj Turnout Bearer
WIN - 0087657	Work Instruction - Service Turnout per Way Welding RBM
WIN - 0087658	Work Instruction - Service Turnout per Way Welding SNX
WIN - 0096245	Work Instruction - Replace Rail
WIN - 0102286	Work Instruction - Ballast Dropping (Remote)
WIN - 0102849	Work Instruction - Mobile Flashbutt Welding
WIN - 0104402	Work Instruction - Re-rail Operations
WIN - 0106222	Work Instruction - Unloading Rail Steel Train
WIN - 0106278	Work Instruction - Picking up Rail Steel Train
WIN - 0106581	Work Instruction - Inspecting Access Roads

Document ID	Title / Description
WIN - 0106584	Work Instruction - Remove / Replace Handrails - DeGrey Bridge
WIN - 0106586	Work Instruction - Fastening Bolts on Bridge Structures
WIN - 0106589	Work Instruction - NDT of Infrastructure
WIN - 0106590	Work Instruction - Timber Transom Bridge Inspections
WIN - 0108666	Work Instruction - Rail Stress Testing
WIN - 0109654	Work Instruction - Fixed Flashbutt Welding Operations
WIN - 0109975	Work Instruction - Condition Based Switch Tamping Inspection
WIN - 0109976	Work Instruction - Condition Based Tamping Track Inspection
WIN - 0112354	Work Instruction - Sleeper Replacement
WIN - 0112355	Work Instruction - Ballast Pan Hungry Board Replacement
WIN - 0112356	Work Instruction - Repair Access Road Washout
WIN - 0118434	Work Instruction - Ballast Remediation (Boghole)
WIN - 0106581	Work Instructions - Inspecting Access Roads
WIN - 0126987	Work Instructions - Minor Mech Service Switch
WIN - 0126622	Work Instructions - Minor Switch Service Register-Hedland Yard
WIN - 0126624	Work Instructions - Minor Switch Service Register-Hedland ML
WIN - 0126625	Work Instructions - Minor Switch Service Register-Mooka
WIN - 0126626	Work Instructions - Minor Switch Service Register-Redmont
WIN - 0126627	Work Instructions - Minor Switch Service Register-Yandi
WIN - 0126628	Work Instructions - Minor Switch Service Register-Newman
WIN - 0126629	Work Instructions - Minor Switch Service Register-Newman Yard
WIN - 0018007	Work Instructions - Major Mech Service Switch
WIN - 0126953	Work Instructions - Switch Measurements
WIN - 0110676	Work Instructions - Switch Measurements from RBM
WIN - 0110677	Work Instructions - Switch Measurements from SNX
WIN - 0087641	Work Instructions - Grind and lube Turnout RBM
WIN - 0087639	Work Instructions - Grind and lube Turnout SNX
WIN - 1070096	Work Instructions – Hand Grind AREMA Style Switch Blades
WIN - 1073573	Work Instruction - Grinding Rail Bound Manganese (RBM) Frog
WIN-RTS-RTM-100	Work Instruction - Hand Tamping (Hydraulic, Pneumatic & Petrol)

Document ID	Title / Description
WIN-RTS-GEN-001	Work Instruction - Steel Train - Loading of Long Welded Rail with Gantry Cranes
WIN-RTS-PMI-001	Work Instruction - Daily Access Roads Inspection (Road Signage and Guide Posts)
WIN-RTS-PMI-002	Work Instruction - Daily Access Roads Inspection (Road Surface & Culverts)
WIN-RTS-PMI-003	Work Instruction - 6 Monthly Access Roads Inspection
WIN-RTS-RTM-076	Work Instruction - Clamp Rail Defect
WIN-RTS-RTM-090	Work Instruction - Gemco Re-Sleepering Machine (Operation of)
WIN-RTS-RTM-092	Work Instruction - Replace Turnout Check Rail
WIN-RTS-RTM-096	Work Instruction - Hi Rail (Operation of)
WIN-RTS-RTM-098	Work Instruction - Level Crossing (Crossing over with Track Mounted Machinery)
WIN-RTS-RTM-099	Work Instruction - Installation of Level Crossings (Concrete Panels)
WIN-RTS-RTM-102	Work Instruction - Replace Insulated Rail Joint (Mechanical)
WIN-RTS-RTM-104	Work Instruction - Use of Oxy & Propane Gas
WIN-RTS-RTM-106	Work Instruction - Rail Drill (Operation of Rotorbroach)
WIN-RTS-RTM-118	Work Instruction - Sleeper Pads (Changing of)
WIN-RTS-RTM-122	Work Instruction - Replace Turnout Stock Rail & Switch Blade
WIN-RTS-RTM-124	Work Instruction - Replace Turnout Crossing (Frog)
WIN-RTS-RTM-125	Work Instruction - Switches (Servicing of)
WIN-RTS-RTM-127	Work Instruction - Aluminothermic Welding
WIN-RTS-RTM-129	Work Instruction - Re-railing (Lengths of 25m or less)
WIN-RTS-RTM-134	Work Instruction - Ballast Dropping (Main Line)
WIN-RTS-RTM-135	Work Instruction - Ballast Train Plough (Operation of)
WIN-RTS-RTM-149	Work Instruction - Daily Access Road Inspections
WIN-RTS-RTM-150	Work Instruction - 6 Monthly Access Road Inspections
WIN-RTS-RTM-176	Work Instruction - Application & Removal of Clips & Fastenings
WIN-RTS-RTM-177	Work Instruction – Cutting Rail
WIN-RTS-RTM-178	Work Instruction - Turnout - Stock Rail Replacement (Yard)
WIN-RTS-RTM-183	Work Instruction - Front End Loader Operation
WIN-RTS-RTM-187	Work Instruction - Installation of Level Crossings (STRAIL)
WIN-RTS-RTM-189	Work Instruction - Remove/Replace Plates
WIN-RTS-RTM-190	Work Instruction - Switch Grinding

Document ID	Title / Description
SPR-RTS-GEN-001	Work Instruction – Broken Rail Procedure
Procedure 0129504	Tamping Strategy
Procedure 0130845	Flashbutt Welding of Rail
Procedure 0130898	Aluminothermic Welding of Rails
Procedure 0130701	Rail Stress Management
Procedure 0131834	Non-Destructive Testing of Rail and Rail Welds
Procedure 0143489	Rail Infrastructure Defect Management
Procedure 0131231	Machine Profiling of Rails – Plain Track and Turnouts
Procedure 0116148	Temporary Speed Restriction
Procedure 0149538	Procedure - Rail Control Blast Affecting Rail Corridor Procedure
Reference 0152351	External Organisation Interface Agreement Register - Level Crossings
Reference 0147644	Western Cullen Hayes Derailer Procurement Reference Guide
Reference 0132651	Install IRJ Keyway Material (Epoxy Resin)
Reference 0170096	Hand-Grind AREA-Style Switch Blades
Reference 0173018	Grinding to Prevent Field Side Cracking in Switch Blades
Reference 0174451	Rail Types and Uses

1.2.11.3. SPO

The following documents can be found in SmartPlant:

Document ID	Title / Description
000-C-12012	Roads Typical Sections
000-C-12013	Road Furniture – Typical Details
000-C-12058	Location Signs and Markers - Layout and Details
000-C-12059	Survey Track Monument - Post Position and Plate Layout
000-C-12085	Rail Embankment and Access Track - Typical Sections
000-C-12086	Level Crossing Typical Vertical Alignment
000-C-12088	Level Crossing Approach Typical Section
070-C-13563	Typical Level Crossing Drainage Details
000-M-00067	Railway Rolling Stock - Line Clearance Diagrams
000-R-00022	Passive Level Crossings Road Signage
000-R-00023	Active Level Crossings Road Signage

Document ID	Title / Description
000-R-00024	Zero Cant and 1:60 Cant Reducing Bearers - Mainline Turnout Installation
000-R-00025	1:60 Cant Reducing Bearers - Yard Turnout Installation
000-R-00029	Typical IRJ Placement – 1:10, 1:15 and 1:20 Turnouts
000-R-00030	Typical IRJ Placement – 1:10, 1:15 and 1:20 Crossovers
076-M-01287	Load out Tunnel Clearance Diagrams
003-M-12003	Car Dumpers – Locomotive and Ore Car Clearance
070-C-13421	Embankment Fall Protection – Typical Details
073-C-00461	Concrete Sleeper Manufacturing Plant - Prestressed Concrete Sleepers Details
073-C-12583	Pandrol Rail Clip Type e2043
073-R-00100	Hytrel Rail Pad
073-C-00579	Turnout - 1:10 R221 RH 68kg RBM Screw Spike Layout Drawing
073-C-00580	Turnout - 1:10 R221 LH 68kg RBM Screw Spike Layout Drawing
073-C-12255	Turnout - 1:10 R221 RH 68kg RBM Resilient Fastening Layout Drawing
073-C-12256	Turnout - 1:10 R221 LH 68kg RBM Resilient Fastening Layout Drawing
073-C-00623	Turnout - 1:15 R320 LH 68kg RBM, Screw Spike, fanned concrete bearers and fixed brace plate (A0B13771)
073-C-00614	Turnout - 1:15 R320 RH 68kg SNX, Screw Spike, fanned concrete bearers and fixed brace plate (A0B10650)
073-C-00615	Turnout - 1:15 R320 LH 68kg SNX, Screw Spike, fanned concrete bearers and fixed brace plate (A0B12637)
073-C-12009	Turnout - 1:15 R320 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B13815)
073-C-12010	Turnout - 1:15 R320 LH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B13815)
073-C-12014	Turnout - 1:20 R910 RH 68kg SNX, Resilient Fastening, concrete shelf bearers and fixed brace plate (A0B14977)
073-C-12015	Turnout - 1:20 R910 LH 68kg SNX, Resilient Fastening, concrete shelf bearers and fixed brace plate (A0B14996)
073-C-12605	Turnout - 1:15 R320 RH 68kg RBM, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15479)
073-C-12606	Turnout - 1:15 R320 LH 68kg RBM, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B18409)
073-C-12261	Turnout - 1:15 R320 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15114)
073-C-12262	Turnout - 1:15 R320 LH 68kg SNX, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15115)
073-C-12562	Turnout - 1:15 R320 RH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B19760)

Document ID	Title / Description
073-C-12563	Turnout - 1:15 R320 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B19761)
073-C-12273	Turnout - 1:20 R910 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B15482)
073-C-12274	Turnout - 1:20 R910 LH 68kg SNX Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B15483)
000-R-00035	Turnout - 1:20 R910 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00036	Turnout - 1:20 R910 RH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00003	Turnout - 1:20 R1000 RH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00004	Turnout - 1:20 R1000 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00026	1:10 Turnout Construction and Maintenance Pad
000-R-00027	1:15 Turnout Construction and Maintenance Pad
000-R-00028	1:20 Turnout Construction and Maintenance Pad
073-C-12573	Minimum Rail Clearance for Dual Tyre Rail Vehicles
073-R-00041	IRJ Location between Crossover and Turnout
073-R-00047	IRJ High Modulus 68kg – Machined Parallel 4mm Height Reductions
073-R-00048	Transition Rails
073-R-00168	68kg Rail with Crossing Panel Assembly
076-M-01285	Rolling Stock Handbook - Index Page
076-M-01286	Rolling Stock Handbook - Loading Gauge and Structure Clearance Diagrams
076-M-01287	Rolling Stock Handbook - Loadout Tunnel Clearance Diagrams
DESC-000-C-00001	Design Criteria - Track Design
DESC-000-C-00002	Design Criteria - Earthworks and Drainage
DESC-073-R-00001	Protection Against Unauthorised Rolling Stock Movements
FUSP-000-E-00004	Functional Specification - Signalling
PREP-073-R-00034	Type Approval Report – Hytrel Pads
PREP-073-R-00036	Rail Wear Report – Lookup Table
PREP-073-R-00043	Track Geometry Standard Deviations and TCI.
PREP-073-R-00046	Vossloh IRJ Lab Test Report
PREP-073-R-00047	Superelevation Design for BHPIO (Monash-RT-2018-1365)
SPEC-000-C-00117	Specification - Tracklaying Construction Requirements

Document ID	Title / Description
SPEC-000-C-12001	Specification - Ballast Manufacture and Supply
SPEC-000-C-12004	Specification - Design, Manufacture and Supply Heavy Haul Railway Derailer
SPEC-000-C-12005	Specification - Design, Manufacture and Supply of Turnouts, Catchpoints and Insulated Rail Joint
SPEC-000-C-12006	Specification - Design, Manufacture and Supply of Buffer Stop
SPEC-000-C-12007	Specification - Heavy Haul Rails
SPEC-000-C-12008	Specification - Heavy Haul Railway Level Crossing Panels
SPEC-000-C-12009	Unsealed Access Roads
SPEC-000-R-00001	Specification - Prestressed Concrete Sleepers - Design, Manufacture and Supply
SPEC-000-R-00002	Specification – Numbering and Titling Rail Asset
SPEC-000-S-00053	Specification - General Demolition Requirements
SPEC-006-E-12122	Specification - Level Crossing Design and Construction
SPEC-076-G-00005	Specification - Minimum Performance Standards for On-Track Vehicles
SPEC-077-M-00002	Specification - Rail Grinding Machine
SPEC-000-R-00009	Specification - Under Track Services
TMAN-000-C-12005	Level Crossing Panels – Strail Panels
TMAN-000-R-00004	Level Crossing Panels – JD Rail Solutions 150, 250 and 500 Tonne Panels
TMAN-075-C-12005	Level Crossing Panels – Humes Precast Concrete Panels
TMAN-000-C-12006	Western Cullen Hayes Uni-directional Derailer and Crowder Assembly
TMAN-000-R-00002	Western Cullen Hayes Bi-directional Derailer and Crowder Assembly
TMAN-073-R-00015	Siemens D150 Derail & C150 Crowder. Mk I and Mk II
TMAN-073-C-12001	Turnout - 1:10 R221 68kg SNX Resilient Fastening
TMAN-074-C-00004	Turnout - 1:10 R221 68kg RBM Screw Spike
TMAN-000-C-12003	Turnout – 1:10 R221 68kg RBM Resilient Fastening
TMAN-000-C-12001	Turnout - 1:15 R320 68kg SNX Resilient Fastening Turnout
TMAN-000-R-00014	Turnout - 1:15 R320 68kg SNX VCD Resilient Fastening
TMAN-073-R-00003	Turnout - 1:15 R320 68kg SNX VCD System Rodding
TMAN-000-C-12002	Turnout - 1:20 R910 68kg SNX Resilient Fastening
TMAN-000-R-00005	Turnout - 1:20 R910 68kg SNX VCD Thick Wed Resilient Fastening
TMAN-000-R-00006	Turnout - 1:20 R910 68kg SNX VCD System Rodding
TMAN-000-R-00001	Turnout - 1:20 R1000 68kg SNX VCD Thick Web Resilient Fastening

1.2.11.4. Standards

The following documents are Australian Standards:

Document ID	Title / Description
AS 1085	Railway Track Material (All Parts)
AS 1085.1	Railway Track Material - Steel Rails
AS 1085.10	Railway Track Material - Rail Anchors
AS 1085.13	Railway Track Material - Spring Fastening Spikes for Sleeper Plates
AS 1085.14	Railway Track Material - Prestressed Concrete Sleepers
AS 1085.19	Railway Track Material - Resilient Fastening Assemblies
AS 1085.2	Railway Track Material - Fishplates
AS 1085.20	Railway Track Material - Welding of Steel Rail
AS 1085.3	Railway Track Material - Sleeper Plates
AS 1085.4	Railway Track Material – Fishplate bolts and Nuts
AS 1085.7	Railway Track Material - Spring Washers
AS 1085.8	Railway Track Material - Dogspikes
AS 1929	Non-Destructive Testing – Glossary of Terms
AS 2083	Calibration Blocks and Their methods of Use in Ultrasonic Testing
AS 2207	Non-Destructive Testing – Ultrasonic Testing of Fusion Welded Joints in Carbon and Low Alloy Steel
AS 3600	Concrete Structures
AS 3818 Parts 1 and 2	Timber—Heavy Structural Products— Visually graded
AS 3998	Non-Destructive Testing – Qualification and Certification of Testing Personnel
AS 4100	Steel Structures
AS 4799	Installation of Underground Utility Services and Pipelines with Railway Boundaries
AS 5100	Bridge Design
AS/NZ ISO 3834	Quality Requirements for Fusion Welding of Metallic Materials
AS 1742.7	Manual of Uniform Traffic Control Devices - Railway Crossings
AS 1743	Road Signs – Specifications
AS 4292	Railway Safety Management
AS 7724	Unauthorized Movement Protection – Operational Requirements
AGRD03/10	Austroads publication – Guide to Road Design – Part 3: Geometric Design
AREMA Ch 1.4 Engineering	American Railway Engineering and Maintenance-of-way Association – Chapter 1, Part 4 Culverts

Document ID	Title / Description
AREMA Ch 10	American Railway Engineering and Maintenance-of-way Association – Chapter 10, Structures, Maintenance and Construction
AREMA Ch 15	American Railway Engineering and Maintenance-of-way Association – Chapter 15, Steel Structures
ROA W2-89-1-92	Ultrasonic Testing of Rail in Railway Applications
AS 7642	Turnouts and Other Special Track
AS 7635	Track Geometry
	AREMA - American Railway Engineering and Maintenance-of-Way Association Portfolio of Trackwork Plans

2. Assets

2.1. Track

2.1.1. Types and Use

Newly constructed track shall be designed and constructed in accordance with the relevant specifications listed in Section 1. Reconstruction of track as part of a maintenance function shall be carried out in accordance with the relevant sections of this document. Newly constructed track or track upgrade areas shall be designed and constructed in accordance with the relevant specifications listed in Section 1. To align with minimum safe working practices, all activities shall be undertaken in compliance with Document 0168096 – RRB RULE GR01 Rail Network Safety and 0168126 - RRB RULE WT01 Planning Work in the Rail Network.

Track monuments shall be installed for all new construction and track upgrade areas. Track monuments shall conform to design drawing 000-C-12059.

Maintenance of track shall be performed using material defined through Section 1 to tolerances as defined in Section 4. If maintenance takes place whilst trains are in operation and where may be at significant variance from the designed horizontal or vertical alignment (for example skeleton track following ballast cleaning, reconstruction or through track deviations) the following additional guidelines should apply:

- The maximum speed allowed shall be 20 km/h, all movements shall be monitored and controlled from trackside.
- The vertical alignment deviation measured using the mid-ordinate offset of a 10-metre chord at any location should not exceed 25 mm.
- The horizontal alignment deviation measured using the mid-ordinate offset of a 10-metre chord at any location should not exceed 40 mm.

Any work that may short two rails together, including presence of track machines, or break the rail continuity within level crossing approaches (within the level crossing predictor circuit as defined by the approach boards) may activate the crossing with a short warning period. Signals technicians should be consulted prior to the works to mitigate the risk of nuisance activation of the crossing.

All assets, equipment, infrastructure, plant and components for use on the BHPIO Rail Network shall be approved for use. Applications for type approval shall be made using the BHPIO *Type Approval Form* (0138972).

2.1.2. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
DESC-000-C-00001	Design Criteria Track Design
AS 7643	Railway Infrastructure Track Stability
AS 1085	Railway Track Material (All Parts)
000-C-12059	Survey Track Monument - Post Position and Plate Layout
CD - 0168096	RRB RULE GR01 Rail Network Safety.
CD - 0168126	RRB RULE WT01 Planning Work in the Rail Network

2.1.3. Handling and Storing

Assets shall be handled and stored to ensure that they do not suffer damage or cause damage to other assets. Assets shall be clearly identified with appropriate durable markings. Spare materials shall be stored in approved warehouses and inventory managed locations.

2.1.4. Reuse and Disposal

Assets should be reused if:

- It is safe to do so.
- It is reasonably practicable to do so.
- The asset condition allows for continued use.
- All required inspections and tests are carried out prior to reuse.
- The asset meets construction standards as defined within SPEC-000-C-00117.
- Overall material costs can be reduced; and
- Maintenance costs can be maintained or reduced.

Any asset identified for reuse shall be checked for suitability against the points above prior to re- installation into track.

The decommissioning and disposal of any assets within the Rail corridor shall comply with the BHPIO Management of Change Process and be carried out in accordance with the appropriate BHPIO Disposal policies. Consideration should be given to:

- Health.
- Safety.
- Environment; and
- Community.

Large steel components being prepared for removal to scrap shall:

- Have a visible and obvious area of the material/component (typically the upward facing surface).
- Be painted with red paint; and
- Be placed in a safe and accessible position for ease of collection.

2.2. Rail

2.2.1. Types and Installation

The predominant rail section in use on the BHPIO Railroad is 68kg/m. Other rail sections are currently present in localised areas, e.g. 71kg/m and smaller sections on some low category tracks. Any renewal of rails shall only be completed using 68kg/m rail unless otherwise approved by the Rail Engineering Manager.

For details including, but not limited to, manufacturing and quality requirements, mechanical chemical properties and steel grade refer to SPEC-000-C-12007.

2.2.1.1. Rail Section

The accepted rail section for use on the BHPIO Railroad for both new construction and maintenance of existing track is 68 kg/m. The nominal dimensions of 68 kg/m rail shall be based on AS1085.1 and comply with the requirements given in SPEC-000-C-12007. The equivalent AREMA rail section is 136RE.

2.2.1.2. Rail Types

The following table designates rail types that are or may be available for installation on the BHPIO Railroad. In addition to those listed, other older rail types may be present in some locations and will be replaced during the rerail activities. Other rail types may be present from previous installations, including types of standard carbon rail.

Rail grades are not to be used without reference and strict adherence to the relevant stationary and mobile Flashbutt welding requirements.

Table 2-1 Approved Rail Types

Manufacturer	Steel Grade	Identification Mark	Track Category 1	Track Category 2	Track Category 3
Nippon Steel Corporation (NSC)	HE400	HE400 136 Nippon	✓	✓	✓
	HEX (68kg)	HE-X	✓	✓	✓
	HEX (71kg)	141 AB	**X**	*Only with prior written approval from the relevant SME **Non-Preferred*	
JFE Steel	SP3	SP3	✓	✓	✓
Voestalpine Schienen (VAE)	UHC400	UHC / DO V	**X**	**X**	✓
OneSteel	Head Hardened (HH)	ONE	**X**	**X**	✓
BHP	BHP HH	BHP	**X**	**X**	✓
Arcelor	R350HT/Low alloy	Thick Web	*Used only in turnouts, switches etc.*		
Voestalpine Schienen (VAE)	R350HT/Low alloy	Thick Web			
Pangang	PG4HT	PG4	*Only with prior written approval from the relevant SME **Non-Preferred*		

The rail types shown in the table above are identifiable by marks on the web of the rail. Examples of how to identify these can be found in reference document 0174451 – Rail Types and Uses.

Note:

1) OneSteel (HH) rail plugs are NOT to be installed in Category 1 or Category 2 Tracks
2) Rail for turnout manufacturing shall not be stamped.

2.2.1.3. Rail Head Profile

New 68 kg/m rail should be supplied with the specific BHPIO rolled rail head profile, as detailed in SPE-000-C-12007. The BHPIO rolled profile is designed to limit rail grinding works required to install target modified rail profiles.

2.2.1.4. Rail Cant

The rail seat for rail on all concrete sleepers shall provide a 1:30 (nominal) cant (inclination relative to the sleeper).

The rail seat for rail on all timber sleepers shall provide a 1:40 (nominal) cant (inclination relative to the sleeper) and lie within the 1:35 to 1:45 range. Plate cutting into sleeper must be limited to 1:45.

All turnouts shall have a flat rail seat (zero cant).

Transition sleepers shall be used for the transition between different rail cants when the rail cant difference is steeper than 1:20.

2.2.1.5. Rail Stress Management

Rail shall be installed within a rail temperature range shown in the table below. Rail temperature shall be measured on the shaded side of the rail. Rail stresses must be managed as detailed and in compliance with Procedure 0130701.

Table 2-2 Design Neutral Temperature (Stress Free Temperature)

Minimum	Maximum
32°C	42°C

Rail installed outside of the DSFT range must be managed in accordance with Rail Stress Management Procedure - 0130701.

2.2.1.6. Closure Rails/Rail Plugs

Closure rails/Rail plugs shall conform to the following criteria in addition to other requirements in Section 2.2.4:

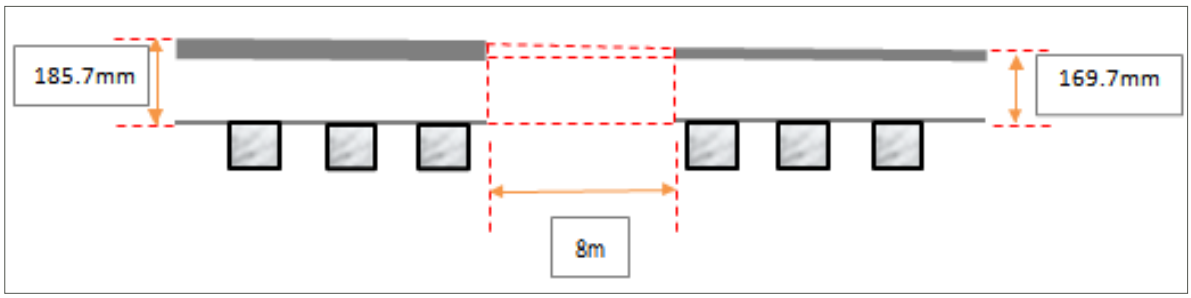
- The head profile shall be compatible with the rail head profile of the rail to be removed such that rail misalignments are not introduced into track.
- The maximum allowable difference in rail height using standard welds is 3mm. If the difference is greater than 3mm then a transition rail should be used.
- Closure rails/Rail plugs should preferably have head height that is more than the surrounding parent rail head height. Where a Closure rail/Rail plug has lesser head height than the surrounding parent rail, it can cause re-rail activities to be required earlier than planned when the plug reaches minimum head height limit. If this has occurred, one option (to avoid re-rail) is to replace the plug at that time.
- Closure rails/Rail plugs shall have a minimum length of 6m on tangents and 9m on curves; and
- Within turnouts, welds are to be a minimum of 1.2m from another weld or rail joint (mechanical or glued) however the distance should be lengthened as far as is practicable. For this purpose, the turnout is considered to be from the point of switch to the last long/common bearer. At locations outside these extents, where it is deemed unavoidable prior approval shall be sought from the Rail Engineering Manager or their delegate.

2.2.1.7. Transition Rails

Transition rails are to be used to join rails of different heights and should be considered for any difference in rail height. Transition rails shall always be used when the rail height difference exceeds 3mm. Transition Rails shall conform to the following criteria:

- Rail height shall be machined from new rail (185.7 mm) at a rate not steeper 2mm per metre over a minimum length of 8m as shown in Figure 2-1.
- Rail head profile shall be maintained.
- Installation of transition rails on a single rail is acceptable though not desirable.
- When installed on both rails, transition rails shall be installed directly opposite each other.
- Staggering of transition rails is not permitted; and
- Other criteria as per Drawing 073-R-00048 – *68kg Transition Rail Tapered*.

Figure 2-1 Design Taper of Transition Rail



2.2.1.8. Rail Lubrication and Friction Modifying Agents

Rail lubrication is currently only in use on the check rail on the departure side of Car Dumper 2 in Hedland Yard.

2.2.1.9. Rail in TLO's and Level Crossings

Rail corrosion protection shall be applied to the rail in TLO's and level crossings, and galvanised clips shall be used.

2.2.2. Reference Documents

Document Reference / ID	Title / Description
DESC-000-C-00001	Design Criteria Track Design
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
Procedure 0130845	Flashbutt Welding of Rail
SPEC-000-C-12007	Heavy Haul Rails
Procedure 0130898	Aluminothermic Welding of Rails
AS 1085.1	Rail Track Materials - Steel Rails
WIN – 0109654	Fixed Flashbutt Welding Operations
WIN – 0102849	Mobile Flashbutt Welding
WIN-RTS-RTM-127	Aluminothermic Welding
WIN-RTS-GEN-001	Steel Train - Loading of Long Welded Rail with Gantry Cranes
WIN – 0106222	Unloading Rail Steel Train
WIN – 0106278	Picking up Rail Steel Train
WIN – 0104402	Re-rail Operations
WIN-RTS-RTM-129	Re-railing (Lengths of 25m or less)
WIN – 0096245	Replace Rail
WIN-RTS-RTM-076	Clamp Rail Defect
Procedure 0130701	Rail Stress Management

2.2.3. Handling and Storage

Bruised or damaged rails can cause broken rails in track. All rail should therefore be handled so as to minimise damage to the rail. To ensure that potential damage caused by transportation, handling and installation of rail is minimised, the procedures listed in Section 2.2.2 shall be adhered to.

When rail that has the potential for reuse is being recovered from track, care should be taken to minimise any damage that may be caused.

If damaged rail is observed during installation, it should be replaced where practicable, otherwise it shall be inspected, plated and clamped, and have a 25 km/h TSR applied until it is replaced.

Closure rail/Rail plugs shall be stored and handled in accordance with the below and as indicated in section 2.2.1.6.

- Closure rail/Rail Plug stacks will be required to support each Maintenance Depot.
- Rail of various sizes from 183mm, 180mm, 177mm, 174mm, 171mm and 168mm will be required.
- The rail shall be identified with following.
    - Rail head height; and
    - Ultrasonic tested date. The ultrasonic operator shall place their initials on the rail.

2.2.4. Reuse and Disposal

Other than for use as part worn Closure rails /Rail plugs, rail shall not be re-used in Category 1 track.

Where possible, the rail plug should match the parent rail type it is being welded to irrespective of the approved types in Table 2-1. If this is not possible then the approved rail types of Table 2-1 shall apply.

All used rails shall be quarantined until sorted, inspected, tested, and classified based on assessment against the following criteria, and as per Section 4.3:

- Each rail shall be ultrasonic tested for internal defects.
- Each rail shall be visually inspected for corrosion and mechanical damage:
- Each rail shall be visually inspected for the presence of:
    - Top and side wear.
    - Rail cross section.
    - Gauge face angle.
    - Rail end straightness.
    - Rail twist; and
    - Metallurgical properties.
- No welds are permitted in the rail length.

All rail shall be selected to match side wear to ±1mm of the surrounding parent rail.

Rail that has the potential for reuse shall be marked in such a manner that its reuse potential is clear and unambiguous. In particular, the rail should be marked, and be segregated into stacks differentiated by:

- Rail size and lengths; and
- Amount of wear.

Where rail requires further classification, it shall be quarantined from reusable rail to prevent its use back in track.

All non-reusable rail components shall be clearly marked and disposed of as soon as practicable after release from track as per Section 2.1.4. Rail being prepared for removal to scrap shall:

- Have a visible and obvious area of the rail (typically the upward facing surface) painted with red paint; and
- Be placed in a safe and accessible position for ease of collection.

Transposing of rails shall not be carried out. Where historical transposed rail exists in track, removal priority and timeframe shall be determined by track inspectors taking into account wear and location history.

2.3. Sleepers

2.3.1. Types and Installation

Pre-stressed concrete sleepers and bearers shall be designed and manufactured in accordance with the methods described in AS1085.14 and SPEC-000-R-00001. Commissioning of new sleepers onto the BHPIO Railroad shall be accompanied by appropriate testing documentation and certification. Sleeper design shall facilitate the following:

- 1435mm gauge.
- 68kg/m rail to AS1085.
- 1:30 rail cant.
- Sleeper spacing at 600mm.
- Resilient fastenings.
- 40 tonne nominal axle load; and
- 80km/h operating speed.

Timber grade and performance requirements for timber sleepers and bearers shall be in accordance with AS 3818 Parts 1 and 2.

Timber and concrete bearers for turnouts may also be designed using the beam on elastic foundation analysis similar to that used for sleepers however some additional considerations may be necessary as follows:

- Allowance for additional length of bearers over standard sleepers.
- Allowance for centrifugal forces through curved pairs of rails; and
- Allowance for forces and movements induced from switch motors and other such equipment. Sleepers shall be installed perpendicular to the line of the track with spacing as defined by Table 2-5 ±10 mm. Skewing shall be limited to ±10mm measured at the sleeper ends.

Concrete sleepers shall be used for Track Category 1 and 2 areas. Timber and steel sleepers may still be in use on some Track Category 2 and 3 areas but shall be replaced with concrete sleepers when renewed. Allowable use of different sleeper types is shown in Table 2-4 below.

Hollow steel sleepers may be used for the purpose of housing and protecting cables and equipment. Hollow sleepers shall be designed, constructed and installed in line with relevant specifications/design criteria and comply with the requirements listed above.

Any assets identified for reuse shall also be checked against construction standards (SPEC-000-C-00117).

Table 2-3 Approved Prestressed Concrete Sleeper Suppliers

Manufacture	Track Category 1	Track Category 2	Track Category 3
Austrak-Vossloh	✓	✓	✓
Humes-Holcim	✓	✓	✓

Table 2-4 Allowable Sleeper Types

Sleeper Type	Track Category 1	Track Category 2	Track Category 3
Timber	X	✓	✓
Concrete	✓	✓	✓
Steel	X	✓	✓
Hollow Steel	✓	✓	✓

The sleeper size and spacing for current use on the BHPIO Railroad shall be as follows:

Table 2-5 Sleeper Dimensions

Sleeper Type	Length (mm)	Width (mm)	Height (mm)	Spacing (mm c/c)
Prestressed Concrete	2550 (min)	240 (min)	240 (min)	600 (nom)
Timber	2600 (min)	225 (min)	150 (min)	533 (nom)
Steel (Trak-Lok 2)	2590	300	118	600 (nom)
Prestressed Concrete Turnout Bearers	2600 (min)	248 (min)	248 (min)	600 (nom)
Timber Turnout Bearers	2600 (min)	300 (min)	175 (min)	533 (nom)

For movements of maintenance and construction traffic at low speed, at least one (1) sleeper in every four (4) shall be fastened to the rail in tangent track and at least one (1) sleeper in every two (2) in curves less than 900m radius. For those movements, both rails shall be fastened to the same sleeper.

Note:
In some parts of the rail network the track was constructed with a sleeper spacing of 650mm. During renewal of these locations, consideration should be given to reducing sleeper spacing to 600mm.

2.3.2. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-R-00001	Prestressed Concrete Sleepers Design, Manufacture and Supply Specification
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
073-C-00461	Prestressed concrete sleeper details
AS 3818 Parts 1 and 2	Timber—Heavy structural products— Visually graded
AS 1085.8	Dog spike (Timber Sleepers)
AS 1085.13	Spring fastening for sleeper plates (Timber Sleepers)
AS 1085.3	Sleeper Plates (Timber)
AS 1085.19	Resilient Clip, Shoulder, Insulator, Plates

Document Reference / ID	Title / Description
AS 1085.10	Rail Anchors
AS 1085.14	Railway track material - Prestressed concrete sleepers
WIN–0112354	Sleeper Replacement
WIN-RTS-RTM-090	Gemco Re-Sleepering Machine (Operation of)
CD – 0134139	Sleeper Condition Guide

2.3.3. Handling and Storage

Sleepers and turnout bearers shall be handled, transported and installed in a manner so as to prevent damage to the sleepers or any other track components. Sleepers and turnout bearers shall be stacked on level stable ground using timber packing between layers as per manufacturer recommendation such that unacceptable stresses will not be induced in the sleepers.

2.3.4. Reuse and Disposal

Upon removal from track all sleepers and associated components shall be sorted and segregated into one of the following categories:

- Reusable.
- Quarantine; and
- Disposal.

Sleepers that have the potential for reuse shall be marked in such a manner that the reuse potential is clear and unambiguous. Sleepers selected for reuse shall:

- Be free from cracks.
- Have square, unworn bases.
- Be structurally sound; and
- Be capable of maintaining gauge and support for the rail.

In addition, the design, type (if applicable) and the number of units shall be marked for sleepers segregated into stacks differentiated by:

- Wear or damage to concrete.
- Suitability for use in Category 1, 2 or 3 tracks; and
- Damaged iron shoulder.

Where sleepers require further classification, they shall be quarantined from reusable materials to prevent use back in track.

All non-reusable sleepers and associated components shall be clearly marked and disposed of as soon as practicable after release from track. Non-reusable sleepers include steel sleepers for mainline tracks. Disposal is to be at approved locations or by approved methods.

Non-reusable treated timber sleepers, bearers and transoms shall be quarantined for separate disposal in compliance with environmental requirements.

Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117).

2.4. Fastenings, Insulators and Pads

2.4.1. Types and Installation

Fastening assemblies shall comply with the appropriate Australian Standards as described below. Testing shall meet the criteria for pre-production fastening tests in AS 1085.19. Commissioning of new fastening assemblies onto the BHPIO Railroad shall be accompanied by appropriate testing documentation and certification. Fastenings shall be applied in accordance with the manufacturer's instructions, using approved tools. Each rail seat shall have fastenings properly applied to both sides of the rail foot.

Rail pad and insulators are to be purpose designed to achieve 1435mm gauge with 1:30 rail seat Cant.

Approved rail pad types are Pandrol HDPE and Pandrol Hytrel. Hytrel pads shall be installed where there is a specific requirement, such as (but not limited to) areas with steep gradients exceeding 0.6%, areas with the history of sleeper skewing, bridge structures with transition areas of min. 50m either side and in accordance with the Rail Pad Type Approval Report (PREP-073-R-00034).

Heavy duty insulators (IN55195) are currently used on the field side of the high rail on all sleepers around tight radius curves (<900m radius).

Consideration should be given to the installation of Heavy-duty insulators (IN55195) where there is a specific requirement, such as (but not limited to) the low rail in curves <900m, areas with steep gradients exceeding 0.6%, areas with the history of sleeper skewing, bridge structures and leading into and throughout turnouts.

For tight curves <300m, gauge widening insulators shall be used as per SPEC-000-C-00117.
The Pandrol components used in this application are as follows:

- Pandrol insulator (Heavy Duty) part number 20535 – 13mm.
- Pandrol insulator (Heavy Duty) part number 17302 – 6mm; and
- Pandrol rail pad (*alternative* HDPE) part number RP65178.

Note that Pandrol rail pad (Hytrel) part number 14549 can be used as an alternative to the HDPE rail pad RP65178. In addition, specialist clips are used on steel sleepers. Engineering advice should be sought when dealing with sleeper fastenings on steel sleepers.

2.4.1.1. Resilient Fastening Assemblies

Resilient fastening assemblies shall be used in Category 1 and 2 track. Fastening type shall be Heavy Haul Pandrol "E" type fastenings or equivalent to suit approved concrete sleepers and rail section.

Resilient fastening assembly components shall comply with the appropriate Australian Standards detailed in Section 2.4.2. These standards generally define materials, material tests, manufacture, design/specification of the component, and component testing and compliance.

Testing shall meet the criteria for pre-production fastening tests in AS 1085.14.

2.4.1.2. Non-Resilient Fastening Assemblies

Non-resilient fastenings can only be used on Category 3 track where timber sleepers are still in use.

Non-Resilient fastening assembly components shall be manufactured to conform to the appropriate Australian Standard as detailed in Section 2.4.2.

For tangent track and curved track with Continuously Welded Rail (CWR) the following fastening assembly or equivalent shall be used:

- Double shouldered sleeper plates should be used to provide a nominal Rail Cant of 1 in 40 on tangent track towards the centre of the track (except in special circumstances such as turnouts) (see AS 1085.3); and
- Dogspikes - 4 (four) 19 mm square shank or equivalent per sleeper plate should be used.

Rail anchors should be used to box anchor every 4th sleeper as a minimum. For curves of radius 300m or less, additional fastenings may be necessary to reduce the need for excessive maintenance intervention.

Additional rail anchors may be necessary in areas of significant rail movement. Even with 100% rail anchors, rail movement cannot always be stopped. In these situations, resilient fasteners or other monitoring and maintenance practices should be considered.

2.4.2. Reference Documents

Document Reference / ID	Title / Description
073-C-12583	Pandrol Rail Clip Type e2043
073-R-00100	Hytrel Rail Pad
AS 1085.8	Dog Spike (Timber Sleepers)
AS 1085.3	Sleeper Plates (Timber)
AS 1085.19	Resilient Clip, Shoulder, Insulator, Plates
AS 1085.14	Railway track material - Prestressed concrete sleepers
AS 1085.10	Rail Anchors
WIN-RTS-RTM-176	Application & Removal of Clips & Fastenings
WIN-RTS-RTM-118	Sleeper Pads (Changing of)
PREP-073-R-00034	Type Approval Report – Hytrel Pads

2.4.3. Handling and Storage

Fastenings shall be handled, transported and installed in a manner so as to prevent damage to the fastenings or any other track components.

2.4.4. Reuse and Disposal

Upon removal from track all fastenings shall be sorted and segregated into one of the following categories:

- Reusable.
- Quarantine; and
- Disposal.

Inspection of fastening rail clips may be undertaken for the purposes of assessing the suitability of fastenings for re-use. The inspection shall include a visual inspection of clip and track condition.

Fastenings that are suitable for reuse shall be marked in such a manner that the reuse potential is clear and unambiguous, or the clips shall be immediately returned to Track.

In the following situations clips shall always be replaced with new during re-rail:

- Bridges, including track to 50m on each side of bridge,
- TLOs (OTP limits).
- Car dumpers (OTP limits).
- Curves <900m; and
- Level crossings.

Where fastenings require further classification, they shall be quarantined from reusable materials to prevent reinstallation back in track.

All non-reusable fastenings shall be clearly marked and disposed of as soon as practicable after release from track. Non reusable materials include:

- Pads.
- Insulators; and
- Clips taken from curved track.

2.5. Ballast

2.5.1. Types and Installation

Ballast is provided as part of the track structure to:

- Facilitate corrective adjustment of the track geometry.
- Evenly distribute load to the formation.
- Resist vertical, longitudinal and horizontal movement of the track.
- Allow drainage of water from the track; and
- Provide voids for the storage of contaminants and fouling material.

For material specification and acceptance testing for the supply of railroad ballast refer to SPEC-000-C-12001.

Ballast shall be positioned and suitably compacted up to 50mm (±10mm) below design sleeper base prior to the placement of skeleton track. Ballast shall be laid in layers not exceeding 100mm and compacted by a minimum of 3 passes of a 1400 – 1800kg/m2 vibrating plate or compacting equivalent (e.g. Rollers, Wacker Plates).

Final ballasting, after placement of skeleton track, should be performed via ballast cars. The track should then be mechanically lifted through the final ballast drop. This final lift shall not exceed 60mm.

Placement of skeleton track prior to ballasting should be avoided where possible due to the potential for damage to the formation during track lifts.

Before newly ballasted track of length greater than 25m is accepted into full operation the ballast profile shall be consolidated by means of either:

- Dynamic track stabilising machine, simulating the passage of 100,000 gross tonnes followed by a 45km/h temporary speed restriction until the track geometry is measured, confirmed and approved; or
- The passage of 100,000 gross tonnes at a temporary speed restriction of 25km/h followed by a 45km/h temporary speed restriction until the track geometry is measured, confirmed and approved.

Appropriate follow-up tamping shall be carried out to ensure that the track geometry is within construction tolerances at the end of the consolidation period.

For newly ballasted track of length shorter than 25m the ballast profile shall be consolidated by means of traffic passage at a temporary speed restriction of 45km/h for a minimum of 48hrs and shall include a follow-up tamp within this period. Detailed inspection of track geometry as a minimum shall be carried out after 48hrs and prior to opening the track to normal traffic.

For new track design and construct projects the installed ballast depth will take account of the design loading, the depth and strength of the designed sub ballast capping and the formation.

See SPEC-000-C-12001 for details regarding required ballast grade and mechanical properties.

Table 2-6 Approved Quarries

Quarry	Operator	Track Category 1	Track Category 2	Track Category 3
Tom Price Quarry	Mobile Concrete Solutions	✓	✓	✓
Elazac Quarry	Brookdale	✓	✓	✓
Bea Bea Creek Quarry	PMW Industries	✓	✓	✓

2.5.1.1. Ballast Profile

A typical track cross-section illustrating ballast profile is shown in Figure 2-2.

Ballast shoulder height (**H**) is measured from the base of sleeper. Ballast shoulders are to be flat and level with the underside of the rail for the full width of the ballast shoulder.

Ballast shall not be left high, the maximum permissible ballast height (**H**) is 100mm below the TOR level, anywhere within the ballast profile extending 300mm laterally from the end of the sleepers.

Ballast shoulder width (**W**) is measured from the extreme end of the sleeper, not the visible end when the track is fully ballasted. The measurement extends to the point at which the shoulder slope begins.

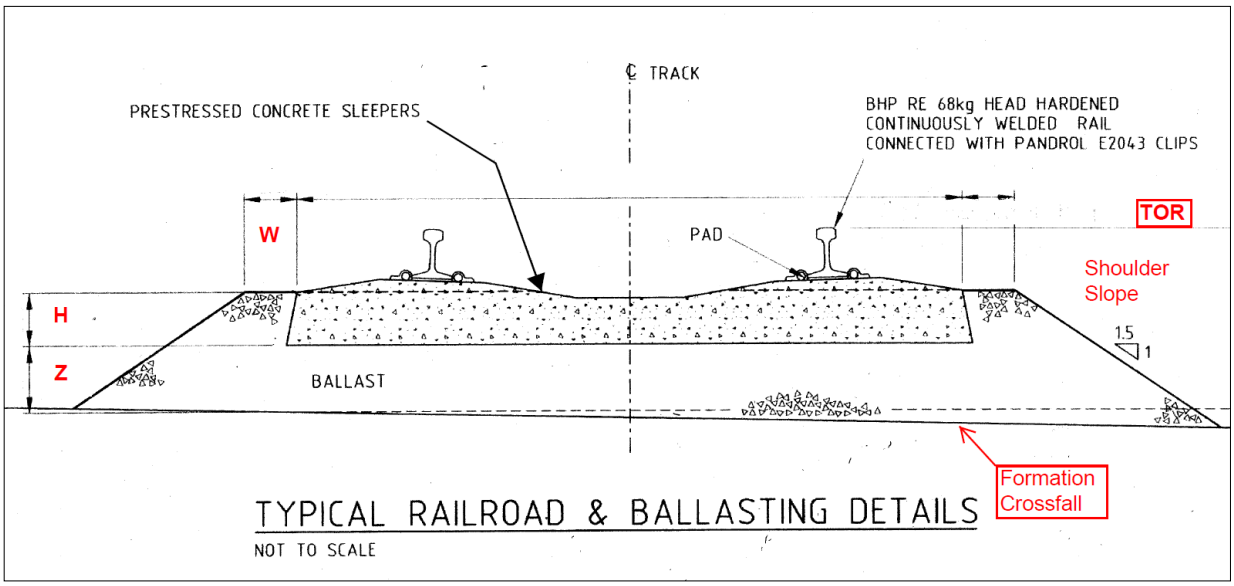
Ballast depth (**Z**) is measured beneath the rail seat (of the low rail on curves) from the base of the sleeper to the bottom of the ballast layer and does not include sub ballast where used. Sufficient ballast depths are critical to minimise and evenly distribute rolling stock loads on the formation. Ballast depths in excess of those shown in Table 2-7 should be avoided as they can result in decreased track stability. Ballast depths in excess of those shown in Table 2-7 require additional engineering controls and if not managed appropriately may result in uncontrolled track settlement causing early degradation of track geometry. Engineering assessment is required in these situations and the method of control shall be approved by the Rail Engineering Manager. These controls include but are not limited to:

- Installation of ‘Geogrid’ into ballast layers.
- Installation of ‘Geoweb’ into ballast layers.
- Increased tamping and maintenance regimes.
- Use of road base instead of ballast in lower layers; and
- Increased compaction during construction.

Ballast cribs shall be full and level with the top of the sleepers.

Formation should be designed to allow maintenance track lifts up to 150mm, with the associated additional ballast profile width, without compromising walkway widths e.g. allow for additional 450mm width of ballast profile at base of ballast.

Figure 2-2 Typical Track Cross-Section & Ballast Profile



Nominal ballast profile dimensions for track on the BHPIO Railroad are given in Table 2-7 Table 2-7 Nominal Ballast Profilesfor different track types and categories.

Table 2-7 Nominal Ballast Profiles

Parameter	Track Type	Track Category 1	Track Category 2	Track Category 3
Minimum Ballast Depth (Z) [*From Base of Sleeper to Top of Formation*]	Tangents Curves ≥ 900m radius Turnouts ≥ 1:20	320mm	250mm	200mm
Minimum Ballast Depth (Z) [*From Base of Sleeper to Top of Formation*]	Curves < 900m Radius Turnouts < 1:20	320mm	250mm	200mm
Maximum Ballast Depth (Z) [*From Base of Sleeper to Top of Formation*]	All Track Types	400mm	400mm	400mm
Shoulder Slope	All Track Types	1:1.5	1:1.5	1:1.5
Maximum Ballast Height (H)	All Track Types	100mm below Top of Rail	100mm below Top of Rail	100mm below Top of Rail
Minimum Shoulder Width (W) [*From Sleeper End*]	Tangents Curves ≥ 900m Radius Turnouts ≥ 1:20	300mm	300mm	300mm
Minimum Shoulder Width (W) [*From Sleeper End*]	Curves < 900m Radius Turnouts < 1:20	550mm	300mm	300mm

A target ballast depth of 320mm on Category 1 track assumes that subgrade strength is unknown. If the subgrade strength can be proven to be sufficient to support a reduced ballast depth then this can be reduced to 300mm.

TLO track used for loaded traffic should have 300mm ballast depth and Yard tracks taking loaded traffic should have 250mm ballast.

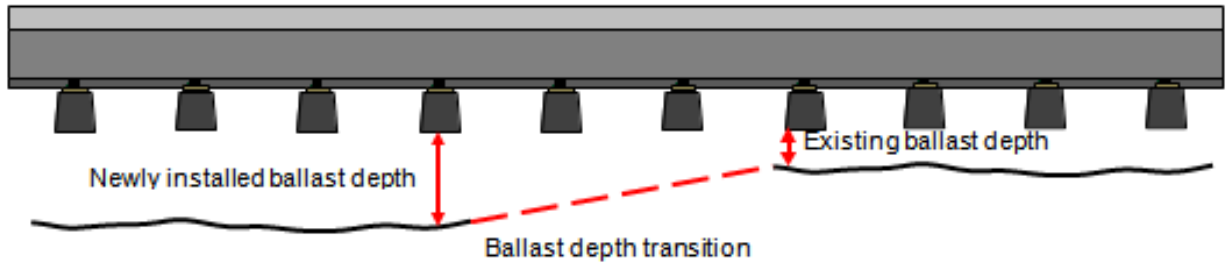
Effective ballast is critical in maintaining surface and sub-surface drainage. Inadequate drainage is detrimental to the ballast and formation and results in accelerated degradation of the ballast and formation resulting in poorer track support and poorer track geometry. Retention of water within the ballast can lead to the formation of bog holes. When >30% of the material is smaller than 13.2mm particle size then the effectiveness of the ballast may be reduced. Consideration should be given to the cost benefit of renewing the ballast compared to the ongoing maintenance requirements to maintain track geometry.

2.5.1.2. Ballast Depth Transitions

Where changes in ballast depths are required (for example at transitions from old ballast track to newly installed ballast track), suitable transitions should be installed.

A rate of 1:100 shall be used to ramp from one depth to another. E.g. a transition from 200mm effective ballast depth to 300mm ballast depth is a change in depth of 100mm, requiring a ramp length of 10m.

Figure 2-3 Ballast Depth Transition



If the change in ballast depth is less than 100mm, or if the length of newly installed ballast is less than 10m then ballast ramps with a length of 1.8m should be installed with constant grade transitions at each end of the works.

2.5.2. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-C-12001	WAIO Standards – Rail Trackwork - Ballast Manufacture and Supply
WIN-RTS-RTM-134	WIN - Ballast Dropping (Main Line)
WIN - 0102286	WIN - Ballast Dropping (Remote)
WIN - 0112355	WIN - Ballast Pan Hungry Board Replacement
WIN - 0118434	WIN - Ballast Remediation (Bog hole)
WIN-RTS-RTM-135	WIN - Ballast Train Plough (Operation of)
WIN – 0087638	WIN - Box Turnout Ballast (Manual)
WIN – 0099690	WIN - Complete Ballast Treatment

2.5.3. Handling and Storage

The handling and storage of ballast within the confines of a quarry or as part of a construction project shall be carried out in line with SPEC-000-C-12001. For all other maintenance activities involving ballast the following applies.

Ballast shall be handled in such a way to avoid contamination and degradation. Vehicles used for handling and transportation shall be clean and free from rubbish and substances which may foul or damage the ballast. Stockpile lay down areas shall be located and prepared to reduce the risk of ballast contamination from underlying ground or from flooding. Relocation and stock piling of ballast shall be minimised as far as is practicable to reduce the risk of contamination and degradation.

When extreme weather events are forecast to impact the BHPIO Railroad then new ballast shall be stored in ballast wagons towards each end of the BHPIO Railroad for the purpose of repair of any potential wash-away. It is recommended that at least 10 fully loaded ballast wagons are stationed towards each end of the railroad in locations that are not susceptible to flooding.

2.5.4. Reuse and Disposal

Ballast shall only be reused in track if it is cleaned of fouling and returned to compliance with the ballast grading requirements in SPEC-000-C-12001.

Suitable ballast may be reused in the construction and maintenance of Ballast drags used in association with catch points and derailers.

All non-reusable ballast shall be quarantined from good material to prevent its use back in track prior to disposal. All non-reusable ballast shall be correctly disposed of as soon as practicable after removal from track, accounting for any environmental considerations concerning contaminants within the ballast as per BHPIO HSE guidelines. Testing may be required prior to removal from the rail corridor.

2.6. Turnouts

2.6.1. Types and Installation

Turnouts comprise of a switch area and a crossing area. There are 3 types of crossings currently in use on the BHPIO Railroad:

- Swing Nose Crossing (SNX) (1:10 / 1:15 / 1:20).
- Monoblock Crossing (1:10 / 1:15); and
- Rail Bound Manganese (RBM) Crossing (1:10 / 1:15).

Any changes to turnout type and assembly are subject to testing and assessment as specified in the SPEC-000-C-12005 and in the Foreword of this Code of Practice. SPEC-000-C-12005 shall be complied with as a minimum when designing new style turnout assemblies.

Common bearer arrangements shall not be included in future designs and installations of crossovers on the BHPIO Railroad due to difficulties in lifting common bearers during maintenance works.

Table 2-8 Turnout SelectionTable 2-8 below details the switch and crossing assemblies that are allowed for use on the BHPIO Railroad, based on track category. Note that some 1:10 SNX assemblies are currently in use on Category 1 track acting as turnouts to backtracks, however the table below shall be complied with for any future installation works.

Table 2-8 Turnout Selection

Crossing Type	Turnout Size	Max Design Diverge Speed	Track Category 1	Track Category 2	Track Category 3
Swing Nose Crossing (SNX)	1:10 Standard (R221.026)	25 km/h	**X**	✓	✓
	1:15 Standard **(1)** (R320m)	35 km/h	✓ **(2)**	✓	✓
	1:15 VCD **(1)** (R320m)	45 km/h	✓ **(2)**	✓	✓
	1:20 Standard **(1)** (R910m)	60 km/h	✓	✓	✓
	1:20 VCD **(1)** (R910)	60 km/h	✓	✓	✓
	1:20 Tangential (R1000m)	65 km/h	✓	✓	✓
Monoblock Crossing	1:10 Standard (R221.026)	25 km/h	**X**	✓	✓
Rail Bound Manganese Crossing (RBM)	1:10 Standard (R221.026)	25 km/h	**X**	✓	✓
	1:15 Standard (R320m)	35 km/h	**X**	✓	✓

Notes:

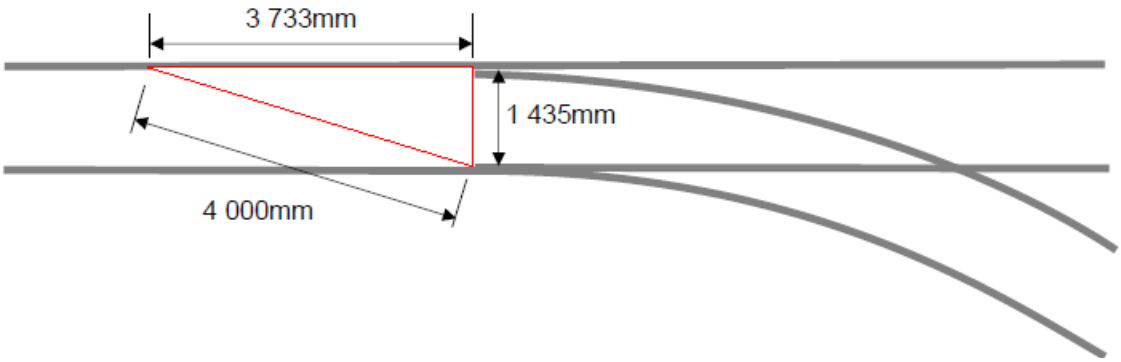
1. All new like for like replacements to be VCD type. Standard types should only be used to replace components during maintenance.
2. 1:20 turnout types preferred in Cat 1 where possible.

Maximum design diverge speed is based on a cant deficiency of 55mm and rounded down to the nearest 5km/h.

All turnouts, Left Hand (LH) and Right Hand (RH) are to be set out and assembled in accordance with the appropriate technical manual or specification. Installation shall be performed by an experienced person and in accordance with the appropriate procedure. Drawings and installation manuals are listed in Section 2.6.2.

Turnouts are to be set out for squareness in accordance with procedures detailed the applicable technical manual. Figure 2-4 below is an example of set out for 1:20 SNX. Bearer No.1 shall be square to stock rails. A calibrated gauge and string line shall be used to ensure squareness.

Figure 2-4 Set Out Example



Transition sleepers shall be used on both the entry and exit of turnouts and installed as per the manufacturer's design drawings.

Turnout bearers are typically deeper than standard sleepers. Consideration should be given to ensuring that required ballast depth is maintained beneath turnouts.

2.6.2. Reference Documents

Document Reference / ID	Title / Description
AS 1085.21	Turnouts, Switches and Crossings
1:10 Turnout TMANS and Drawings	
TMAN-073-C-12001	1:10 R221 68kg SNX Resilient Fastening Turnout
073-C-12255	1:10 R221 RH 68kg RBM Resilient Fastening Layout Drawing
073-C-12256	1:10 R221 LH 68kg RBM Resilient Fastening Layout Drawing
TMAN-000-C-12003	1:10 R221 68kg RBM Resilient Fastening Turnout
TMAN-074-C-00004	1:10 R221 68kg RBM Screw Spike Turnout
073-C-00580	1:10 R221 LH 68kg RBM Screw Spike Layout Drawing
073-C-00579	1:10 R221 RH 68kg RBM Screw Spike Layout Drawing
000-R-00026	1:10 Turnout Construction and Maintenance Pad
1:15 Turnout TMANS and Drawings	
TMAN-000-C-12001	1:15 R320 68kg SNX Resilient Fastening Turnout
073-C-00623	Turnout - 1:15 R320 LH 68kg RBM, Screw Spike, fanned concrete bearers and fixed brace plate (A0B13771)
073-C-00614	Turnout - 1:15 R320 RH 68kg SNX, Screw Spike, fanned concrete bearers and fixed brace plate (A0B10650)
073-C-00615	Turnout - 1:15 R320 LH 68kg SNX, Screw Spike, fanned concrete bearers and fixed brace plate (A0B12637)

Document Reference / ID	Title / Description
073-C-12605	Turnout - 1:15 R320 RH 68kg RBM, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15479)
073-C-12606	Turnout - 1:15 R320 LH 68kg RBM, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B18409)
073-C-12009	Turnout - 1:15 R320 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B13815)
073-C-12010	Turnout - 1:15 R320 LH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B13815)
073-C-12261	Turnout - 1:15 R320 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15114)
073-C-12262	Turnout - 1:15 R320 LH 68kg SNX, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B15115)
TMAN-073-R-00014	1:15 R320 68kg SNX VCD Resilient Fastening Turnout
TMAN-073-R-00003	1:15 R320 68kg SNX VCD System Rodding
073-C-12562	Turnout - 1:15 R320 RH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B19760)
073-C-12563	Turnout - 1:15 R320 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate (A0B19761)
000-R-00027	1:15 Turnout Construction and Maintenance Pad
1:20 Turnout TMANS and Drawings	
TMAN-000-C-12002	1:20 R910 68kg SNX Resilient Fastening Turnout
073-C-12273	Turnout - 1:20 R910 RH 68kg SNX, Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B15482)
073-C-12274	Turnout - 1:20 R910 LH 68kg SNX Resilient Fastening, fanned concrete bearers and fixed brace plate (A0B15483)
TMAN-000-R-00005	1:20 R910 68kg SNX VCD Resilient Fastening Turnout
TMAN-000-R-00006	1:20 R910 68kg SNX VCD System Rodding
000-R-00035	Turnout - 1:20 R910 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00036	Turnout - 1:20 R910 RH 68kg *and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate*
073-C-12014	Turnout - 1:20 R910 RH 68kg SNX, Resilient Fastening, concrete shelf bearers and fixed brace plate (A0B14977)
073-C-12015	Turnout - 1:20 R910 LH 68kg SNX, Resilient Fastening, concrete shelf bearers and fixed brace plate (A0B14996)
TMAN-000-R-00001	1:20 R1000 68kg SNX VCD Thick Web Resilient Fastening Turnout
000-R-00003	Turnout - 1:20 R1000 RH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate
000-R-00004	Turnout - 1:20 R1000 LH 68kg and TW Rail SNX, VCD, Resilient Fastening, fanned concrete bearers and resilient brace plate

Document Reference / ID	Title / Description
000-R-00028	1:20 Turnout Construction and Maintenance Pad
Specifications and Typical Drawings	
SPEC-000-C-12005	Design, Manufacture and Supply of Turnouts, Catchpoints and Insulated Rail joints
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
000-R-00024	Zero and 1:60 Cant Reducing Bearer Mainline Turnout Installation
000-R-00025	1:60 Cant Reducing Bearer Yard Turnout Installation
000-R-00029	Typical IRJ Placement 1:10, 1:15 and 1:20 Turnouts
000-R-00030	Trackwork – Typical IRJ Placement 1:10, 1:15 and 1:20 Crossover
073-R-00041	IRJ Location between Crossover and Turnout
Work Instructions	
WIN-RTS-RTM-092	Replace Turnout Check Rail
WIN-RTS-RTM-122	Replace Turnout Stock Rail & Switch Blade
WIN-RTS-RTM-124	Replace Turnout Crossing (Frog)
WIN-RTS-RTM-125	Switches (Servicing of)
WIN-RTS-RTM-178	Turnout - Stock Rail Replacement (Yard)
0170096	Hand-Grind AREA-Style Switch Blades
0173018	Grinding to Prevent Field Side Cracking in Switch Blades
WIN – 0087639	Grind & Service Turnout SNX
WIN – 0087640	Replace Turnout Closure Rail
WIN – 0087643	Replace Turnout Insulated Rail Joint (Glued)
WIN - 0087648	Tamp Turnout Bearers (Manual)
WIN - 0087649	Lube & Service Turnout SNX
WIN - 0087650	Replace Turnout Heel Blocks
WIN - 0087651	Replace Turnout Rollers
WIN - 0087652	Replace Turnout Spreader Bar
WIN - 0087655	Adjust Turnout Bearer
WIN - 0126987	Work Instructions - Minor Mech Service Switch
WIN - 0126622	Work Instructions - Minor Switch Service Register-Hedland Yard
WIN - 0126624	Work Instructions - Minor Switch Service Register-Hedland
WIN - 0126625	Work Instructions - Minor Switch Service Register-Mooka

Document Reference / ID	Title / Description
WIN - 0126626	Work Instructions - Minor Switch Service Register-Redmont
WIN - 0126627	Work Instructions - Minor Switch Service Register-Yandi
WIN - 0126628	Work Instructions - Minor Switch Service Register-Newman
WIN - 0126629	Work Instructions - Minor Switch Service Register-Newman Yard
WIN - 0018007	Work Instructions - Major Mech Service Switch
WIN - 0126953	Work Instructions - Switch Measurements
WIN - 1073573	Work Instructions - Grinding Rail Bound Manganese (RBM) Frog
WIN - 1070096	Work Instructions – Hand Grind AREMA Style Switch Blades
WIN-RTS-RTM-190	Switch Grinding
WIN-RTS-RTM-189	Remove/Replace Plates

2.6.3. Handling and Storage

Turnout components shall be handled and stored to ensure that they do not suffer damage or cause damage to other assets.

The lifting and storage of turnouts is critical to their long-term performance and reliability. The following Track Engineering Instruction shows mandatory requirements for the lifting and storage requirements.

Lifting and Storage SNX Components

Swing Nose Crossing components shall be always handled with care to ensure the plates are not bumped or damaged in any way. Particular care and attention to be given to protecting the drive rod and detector rod brackets, (which hang below the Swing Nose Crossing) during the unloading and storage process. Swing Nose Crossings and components must be stored level and on timbers of an adequate size to ensure that the brackets protruding from beneath the crossing are always protected.

Frogs shall be lifted on all four (4) legs at the designated lifting points.

Figure 2-5 SNX lifting points, both 1:15 and 1:20

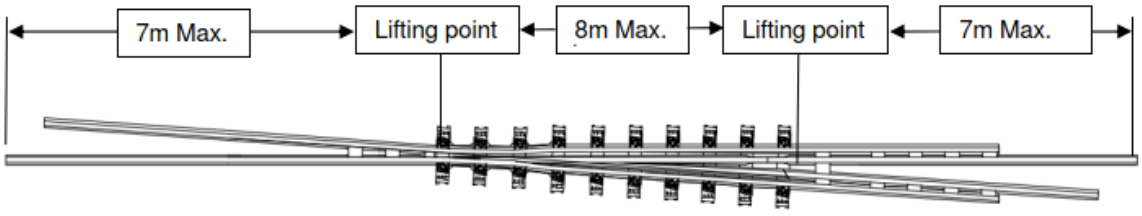


Figure 2-6 1:20 SNX blades and/or stock rails

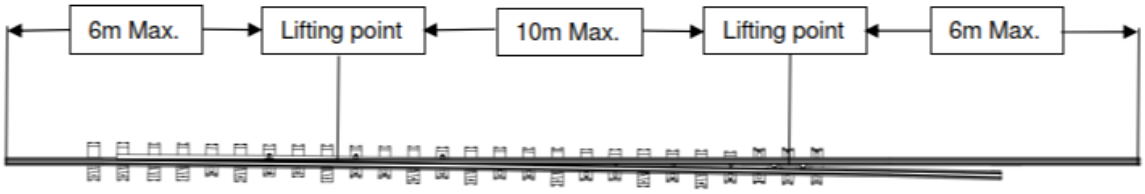
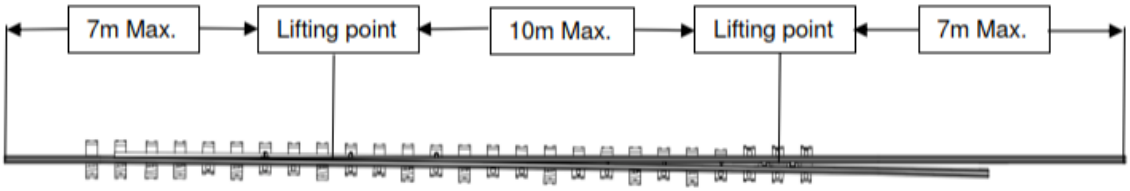
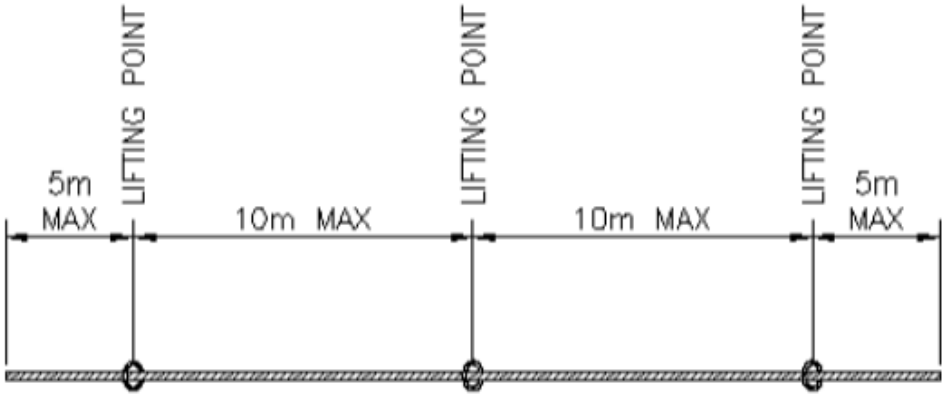


Figure 2-7 1:15 SNX blade and/or stock rails



When cranes are not available, two (2) forklift trucks or loaders with tines may be used. Using the stencilled lifting points as a guide.

Figure 2-8 Plain rail and loose switch blades over 20m



All Lifting Operations shall comply with Lifting Operations Procedure SPR-HIS-SAF-029. Spare materials shall be stored in approved warehouses and inventory managed locations.

2.6.4. Reuse and Disposal

All turnout components shall be quarantined until sorted and classified based on assessment against the following, as per Section 4.3:

- Potential for reuse in other parts of the BHPIO Railroad.
- Presence of internal and surface rail defects, by visual and ultrasonic means of inspection.
- Presence of top and side wear.
- Presence of rail damage; and
- Potential for repair.

Turnout components that have the potential for reuse should be marked in such a manner that their reuse potential is clear and unambiguous. Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117).

All non-reusable rail components shall be clearly marked and disposed of as soon as practicable after release from track as per Section 2.1.4.

2.7. Insulated Rail Joints

2.7.1. Types and Installation

All new insulated rail joints shall be a minimum of Grade A insulated rail joint assemblies in accordance with SPEC-000-C-12005 and use a minimum of six-hole joint bars. For maintenance purposes it is recommended that insulated rail joints are procured with a minimum length of 12.5m.

Insulated rail joints that have been machined down to lower rail heights in order to match existing height shall be used in preference to transition rails. Refer to drawing number 073-R-00047 *IRJ High Modulus 68kg – Machined Parallel*. Using this approach will reduce the number of welds required and is therefore preferable.

Only approved rail types as per Section 2.2.1.2 shall be used for construction of insulated rail joints.

Rail ends are to be straight cut by mechanical device and not flame cut and shall be centrally suspended between sleepers.

Insulated rail joints should be installed in to track using flashbutt welds.

Each pair of insulated rail joints shall be installed in the same sleeper crib, i.e. square, not staggered.

There shall be a minimum distance of 4.8 metres between any weld and the insulated rail joint centre (key). This requires that all insulated rail joints be a minimum length of 9.6 metres when installed into track. Within turnouts the minimum distance from joint centre to nearest weld can be reduced to 1.2m however the distance should be lengthened as far as is practicable. To enable this, consideration should be given to the use of longer length insulated rail joints to remove the requirement for closure rails/welds. For this purpose, the turnout is considered to be from the point of switch to the last long/common bearer. At locations outside these extents, where it is deemed unavoidable prior approval shall be sought from the Area Engineer or Supt.

At signals/mainline switches the insulated rail joints shall be placed a minimum of 3.5m past the signal in the direction of normal travel. At switch toes where there is no signal, the insulated rail joints shall be placed at 14.5m from the switch toes as per 000-R-00029 and 073-R-00041.

During installation of insulated rail joints and any associated transition rails consideration should be given to the lengths of rails and weld positions to facilitate future subsequent replacements.

2.7.2. Reference Documents

Document Reference / ID	Title / Description
000-R-00029	Typical IRJ placement 1:10, 1:15 and 1:20 turnouts
073-R-00041	IRJ Location between Crossover and Turnout
073-R-00047	IRJ High Modulus 68kg – Machined Parallel 4mm Height Reductions
AS 1085.12	Insulated Joint Assemblies
SPEC-000-C-12005	Design, Manufacture and Supply of Turnouts, Catchpoints and Insulated Rail joints
PREP-073-00046	Vossloh IRJ Lab Test Report

Document Reference / ID	Title / Description
0132651	Install IRJ Keyway Material (Epoxy Resin)
Procedure – 0130845	Flashbutt Welding Procedure
FUSP-000-E-00004	WAIO Standard Signalling Design Principles
WIN-RTS-RTM-102	Replace Insulated Rail Joint (Mechanical)
WIN - 0087643	Replace Turnout Insulated Rail Joint (Glued)

2.7.3. Handling and Storage

Insulated rail joints shall be handled, transported and installed in a manner so as to prevent damage to the joint or any other track components.

All rail components shall be stored and stacked in an upright position.

Insulated Rail Joints (IRJ's) should be stored on a minimum of four (4) timbers laterally, with two (2) being placed 1m either side of the joint and two (2) 1 metre from each end.

Insulated rail joints shall be lifted at the indicated lifting points or where no markings exist equal distance from the ends - approximately 4 metres from rail ends.

2.7.4. Reuse and Disposal

Insulated rail joints shall not be reused once removed from track and should be clearly marked and disposed of as soon as practicable after release from track as per Section 2.1.4.

2.8. Mechanical Non-Insulated Rail Joints

2.8.1. Types and Installation

Mechanical rail joint design shall be in accordance with standard Fish-plated joints covered in AS 1085.2 or be equal to or exceed the performance of current proven designs. The standards shown in Section 1.2.11 generally define the materials, material tests, manufacture, design and specification of the components, and component testing and compliance.

Permitted permanent and temporary rail joints are as follows:

2.8.1.1. Permanent Rail Joints

The use of non-insulated rail joints as permanent rail joints is only allowable in Track Category 3 locations and some specific slow speed Track Category 2 locations such as yards and TLO loops including weighbridges. The use of mechanical rail joints in any approved location must have appropriate inspection regimes in place.

Table 2-9 Approved Locations of Mechanical Non-Insulated Rail Joints in Cat 2 Track

Nelson Point Yard				
300A/B		301A/B		303A/B
Newman Yard				
11Sw	12Sw	13Sw	33Sw	44Sw
51Sw	71Sw	72Sw	73Sw	43Sw
14A/B	Tangent track on 2 Rd between 12Sw and 70Sw			
1 Rd/15 Rd between 32Sw and 14A		15B Rd between 31Sw and 33Sw		
16 Rd between 21Sw and 30ASw				
Mines				
J-Hub Loop form J425.000km 65Sw to OB18N4 – J432.600km				
OB24 Loop from OB24Nth N4 to OB24Nth N1 Signal (Loop Only)				
OB25 Spur arrival OTP OB409.400km – OB25S7 Signal 414.600km				
OB18 Loop		Yandi 1 Loop		Yandi 2 Loop (21Sw to 22Sw)

All Category 2 locations not identified in table 2-9 are to utilise FB Welding, or AT welds with the required approval (to assist with tracking), to install components. If any of these locations currently have mechanical joints, they are to be scoped for removal during the next component replacement.

When installing mechanical joints, the current requirements of a 3mm head height difference between adjacent rail sections is to be adhered to and Nordlock washers or equivalent should be used to ensure sound integrity. It is also a requirement that all newly drilled holes shall be chamfered to reduce the possibility of bolt hole cracks. For full instructions refer to WIN-RTS-RTM-106 Rail Drill (Operation of Rotabroach / Hydraulic Power Pack).

When work is undertaken to change from one method of installation to another (i.e. welding to mechanical joints) the track circuit must be recertified by a Signals technician on completion of the task and prior to reinstatement to service.

In crossings, turnouts and other locations where fixed joints are used, the use of swage lock fastenings in lieu of bolts is the preferred alternative method of fastening. However due to the higher forces imposed on the joint components from the tensile loading across this fastening type, joint components should be checked for suitability.

Permanent rail joint design and installation shall include the following:

- A minimum of 6 hole/6 bolt Fish-plated joints.
- Each pair of rail joints shall be installed in the same sleeper crib, i.e. square, not staggered; and
- Joints shall be centrally suspended between sleepers.

Fish-plated rail joint components shall be manufactured to conform to the appropriate Australian Standards referenced in Section 1.2.11.4.

2.8.1.2. Temporary Rail Joints

Robel Clamps

Temporary rail joints may be formed with clamped fishplates provided that a minimum of one full-size Robel clamp or two half-size Robel clamps are used with each fishplate set, as per manufacturer's installation manual. Clamps shall be selected to match the compatible fishplate type.

G-clamps

Temporary rail joints may be formed with clamped fishplates provided a minimum of three G-clamps are used on straight fishplates or a minimum of two G-clamps used on bowed fishplates.

Temporary joints formed using fishplates and clamps in operational Category 1 track shall be subjected to a 25km/h speed restriction and be replaced with permanent joints within 48 hours.

Temporary mechanical rail joints shall only be placed within the track-predictor limits of an actively protected level crossing in conjunction with flagman operation of ALX equipment (urgent repairs only). Permissible repair for broken or substantially cracked rails shall only be via welded rail plugs.

2.8.1.3. Other Joints

Expansion switches, junctions and other permanent joints not covered by AS 1085 shall be supplied in compliance with an approved specification or standard. These joints shall be subject to testing and assessment against the approved specification or standard prior to use on the BHPIO Railroad.

2.8.2. Reference Documents

Document Reference / ID	Title / Description
AS 1085.2	Fishplates
AS 1085.4	Fishbolts and Nuts
AS 1085.7	Spring Washers
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
WIN-RTS-RTM-076	Clamp Rail Defect and Installation of Rail plug
SPR-RTS-GEN-001	Broken Rail Procedure
WIN-RTS-RTM-106	Rail Drill (Operation of Rotorbroach)
WIN-RTS-RTM-107	Rail Drill (Operation of)

2.9. Welded Rail Joints

2.9.1. Types and Installation

2.9.1.1. Flashbutt Welds

Fixed flashbutt welding operations and (welding using fixed flashbutt welding plant) shall comply with Procedure 0130845 and installed in accordance with WIN-0109654.

Mobile flashbutt welds installed in the field shall comply with Procedure 0130845 and installed in accordance with WIN-0102849.

The welder executing the weld shall be fully trained, competent and hold current certification and Verification of Competency (VOC) to weld on the BHPIO Railroad. All welders shall be qualified as per AS 1085.20.

Welders and welding equipment shall be audited for compliance on a frequency not exceeding one year (i.e. max 12 months). More frequent assessment may be required where evidence of non-conformance is identified. Performance specification should include as a minimum:

- Welding current.
- Upset force or pressure.
- Upset displacement.
- Welding time.
- Location.
- Rail size; and
- Rail grade.

When welding rails together, a maximum height difference of 3mm is acceptable.
If rail height differences exceed this, then a transition rail shall be used as per Section 2.2.

Care must be exercised to ensure correct processes are utilised when welding rails of differing grades.

Confirmation that no visual defects have been identified is documented by completion of a Weld Report. The weld shall be identified on both the Weld Report and on the web of the rail adjacent to the weld.

2.9.1.2. Aluminothermic Welds

Aluminothermic (AT) welds shall not be installed on the BHPIO rail network unless an assessment has been made by Track Renewals and approval has been obtained from the Rail Network Maintenance Manager or their delegate, using the following process:

- An AT Welding Request form is to be completed (for planned and unplanned work) and sent to the Track Renewals FB Team.
- Track Renewals FB is to review the request to assess FB welding solutions. If AT welding is approved the request form is sent to the Rail Network Maintenance Manager (or delegate) for final approval.
- The Rail Network Maintenance Manager (or delegate) will review the request and if approved, the signed form is sent to the requester.
- The track maintenance area supervisor will attach the form to the work 1SAP notification; and
- Any requests for AT welding should be sent as soon as possible to enable recording and potential rectification of issues preventing FB welding.

Any new AT welds installed shall require assessment by the area Weld Inspector to determine if they can be replaced with FB welds. If weld replacement is possible a subsequent notification shall be raised (off the original notification) for replacement of the AT welds within 21 days. Any removable AT weld not replaced with a FB weld within 21 days must be plated and treated as a Sev 2.

Aluminothermic weld materials shall be supplied and proof tested in accordance with methods and frequencies defined in AS 1085.20.

Aluminothermic welding shall be carried out in compliance with Procedure 0130898 and in accordance with WIN-RTS-RTM-127.

The welder executing the weld shall be fully trained, competent and hold current certification to weld on the BHPIO Railroad. Welders shall be qualified based on AS 1085.20 and shall hold the following certifications:

- Cert 2 in Rail Infrastructure.
- Certified as competent for the AT welding procedure that is approved and in use at BHPIO; and
- Welders Assistant Theory/Practical.

Welders shall be audited for compliance on a frequency not exceeding 1 year (i.e. max 12 months). More frequent assessment may be required where evidence of non-conformance is identified. Corrective actions in the event of non- conformances may include withdrawal of the welder certification and/or retraining of the welder.

Care must be exercised when welding rails of differing grades. Approved rail grade types are documented in Section 2.2.

The gap between rails prior to the weld being installed shall be controlled and maintained within the limit values specified in WIN-RTS-RTM-127. Welding rails of different heights shall be closely managed. Height difference between rails shall never exceed 3mm. Step welds for joining rails with different rail heights >3mm shall not be used. In such situations alternatives such as the use of transition rails or machined rail should be considered.

Weld quality shall be initially confirmed by the welder by means of visual observation of the welding process and by completion of a visual inspection after weld installation. This shall be carried out by the welder for every weld installed prior to allowing unrestricted traffic. When a process non-conformance is identified possible corrective actions include:

- Stopping the welding activity.
- Reassessment of the process; and
- Re-work, including potential installation of a new full size rail plug.

Confirmation that no visual defects have been identified is documented by completion of a Weld Report. The weld shall be identified on both the Weld Report and on the web of the rail adjacent to the weld using the following weld identification protocol:

YY MM Welder ID Weld# for month e.g. 2310JD01

2.9.1.3. Welds on Bridges

All rail welds on or within 50m of a bridge shall be Flashbutt type.

Aluminothermic welds should only be used in an emergency or as a temporary repair, if a mobile Flashbutt welder is not available.
Aluminothermic welds on or within 50 metres of a bridge are to be plated and clamped and shall be removed and replaced with a Flashbutt weld within 21 days of installation.

Welds shall be kept to a minimum within the overall bridge span.

2.9.2. Reference Documents

Document Reference / ID	Title / Description
AS 1085.20	Welding of Steel Rail
Procedure – 0130898	Aluminothermic Welding
Procedure – 0130845	Flashbutt Welding of Rails
WIN-RTS-RTM-127	Aluminothermic Welding
SPR-IHS-SAF-071	Hot Works Procedure
WIN-RTS-RTM-104	Use of Oxy and Propane Gas
WIN - 0102849	Mobile Flashbutt Welding
WIN - 0109654	Fixed Flashbutt Welding Operations
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements

Document Reference / ID	Title / Description
AS 3834	Quality requirements for fusion welding of metallic materials
Procedure – 0131834	Non-Destructive Testing of Rail and Rail Welds
Reference - 0174451	Rail Types and Uses

2.9.3. Handling and Storage

Weld material should be handled and stored in accordance with manufacturer's instructions.

2.9.4. Reuse and Disposal

All materials shall be appropriately disposed of as soon as is practicable.

2.10. Level Crossings

Level Crossings throughout the BHPIO Railroad should be clearly identified as one of the following access types:

- Public Level Crossings.
    - Public level crossings are provided to maintain continuity of a public thoroughfare.
- Private (Operations) Level Crossings.
    - Private level crossings are level crossings that provide access only for authorised BHPIO Railroad operations persons.

Passive level crossings rely on the road user to detect the approach or presence of rolling stock by direct observation. Passive protection is the application of traffic control signs and devices which provide an unchanging warning to the road user at a road and railway interface.

Passive controlled crossings are solely for use by BHPIO personnel and Contractors (not for public use). Railway crossings controlled by Stop Signs shall be implemented for all BHPIO passive level crossings unless the ALCAM (Australian Level Crossing Assessment Model) assessment has determined active control devices are required.

Active protection incorporates devices such as flashing lights, boom barriers and bells to warn road users of the approach or presence of rolling stock at a level crossing.

Active level crossings shall be used on all BHPIO roads subject to public use or as a requirement of the ALCAM assessment.

2.10.1. Types and Installation

Table 2.10.1 below defines the approved types of level crossings for installation on the BHPIO Railroad. Note that other level crossing types are currently in operation on the BHPIO Railroad including:

- Those constructed from lengths of welded rail strings.
- Superseded concrete/steel design.
- Superseded Humes crossing panel design; and
- Superseded steel design.

Any renewal of level crossings shall only be completed using types shown in the approved crossing types table below.

Table 2-10 Approved Level Crossing Types

Manufacturer	Model	Track Category 1	Track Category 2	Track Category 3
Strail	N/A	✓	✓	✓
JD	JD150	✓	✓	✓
JD	JD250	✓	✓	✓
JD	JD500	✓	✓	✓
Humes*	N/A (Heavy Duty) Panels)	X	✓	✓

** Humes panels are approved for used within Yard Areas only, not mainline passing tracks / sidings.*

The selection of a suitable level crossing type shall consider the expected vehicle loading and volume of traffic, in addition to the track category and maintenance requirements.

All level crossings are subject to ALCAM assessment which will govern the level of control required. An initial ALCAM assessment is to be completed during the identification phase of a project for the proposed level crossing location, to ensure the physical location is suitable and a safe form of control can be achieved.

When designing and installing level crossings, consideration shall be given to the following:

- Sight distance and obstructions.
- Time for road vehicles to traverse and clear the level crossing.
- Time for pedestrians to clear the level crossing.
- Ability of legal road vehicles with clearance limitations (e.g. Low-loaders) to negotiate the level crossing.
- Design speed of the road.
- Track alignments.
- Method of panel fixation; and
- Superelevation of both track and the road.

Specific consideration should be given to:

- Suitable rail anchoring arrangements.
- Provision of suitable wheel flange way.
- Considering maximum size of wheel flanges of trains allowed through the level crossing, clearance between track gauge and wheel set gauge and track radius through the level crossing.
- Track drainage.
- Maintains track drainage through or appropriately deviated around the level crossing and avoids obstruction to track side drainage systems.
- Provision of road surface water flow away from the crossing.
- A suitable road surface.
- The road configuration.
- Compatibility with the approach road surface.
- Clearances from turnouts, rail welds, curves and insulated rail joints.

- Avoidance of obstruction of track side access roads; and
- Clearances to overhead and adjacent structures.

Level crossing components shall be installed in accordance with the manufacturer's instructions, unless such instructions are non-compliant with this Code of Practice in which case approval from the Rail Engineering Manager shall be required.

Suitable 'geofabric' should be utilised to provide a separation layer between the sub-ballast and track formation and should extend up to the interface between the road pavement sub-base layers and ballast. In addition, underdrainage should be installed as a means of channelling water away from under the level crossing into the cess drains. Drawing 070-C-13563.

In general, the level crossing surface shall be flush with the top of the rail, planar between the two rails and flush with the approach roads.

Road alignment shall be designed in accordance with Austroads publication AGRD03/10: Guide to Road Design – Part 3: Geometric Design, and the requirements of the relevant road authority.

The following shall be confirmed as a minimum, prior to assembly of any level crossing components:

- Fill in track ballast flush with sleeper surface and compact.
- Clear all pavement debris and other foreign materials off track bed.
- Visually inspect all fastenings, retighten if they are loose and replace any damaged or missing fastening & hardware items.
- Apply a uniform layer of anticorrosive paint on both field and gauge sides of the rail head, web and top of foot.
- Use galvanised or sherardised fastenings along the length of the level crossing panels.
- Check the accuracy of sleeper spacing as per manufacturers requirements.
- Check track geometry is to the proper horizontal and vertical alignment; and
- Check there are no additional crossing obstructions (i.e. rail joints).

2.10.2. Reference Documents

Document Reference / ID	Title / Description
DESC-000-C-00001	Design Criteria Track Design
SPEC-000-C-12008	Heavy Haul Railway Crossing Panels Specification
SPEC-006-E-12122	Signal Level Crossing Design and Construction Specification
TMAN-000-C-12005	Level Crossing Panels – Strail Panels
TMAN-000-R-00004	Level Crossing Panels – JD Rail Solutions 150, 250 and 500 Tonne Panels
TMAN-075-C-12005	Level Crossing Panels – Humes Precast Concrete Panels
000-C-12086	Level Crossing Typical Vertical Alignment
000-C-12088	Level Crossing Approach Typical Section
000-R-00022	Passive Level Crossings Road Signage
000-R-00023	Active Level Crossings Road Signage
070-C-13563	Typical Level Crossing Drainage Details

Document Reference / ID	Title / Description
073-R-00168	68kg Rail with Crossing Panel Assembly
AGRD03/10	Austroads – Guide to Road Design – Part 3: Geometric Design
AS 1742.7	Manual of Uniform Traffic Control Devices – Railway Crossings
AS 7658	Railway Infrastructure – Railway Level Crossing
WIN-RTS-RTM-098	Level Crossing (Crossing over with Track Mounted Machinery)
WIN-RTS-RTM-099	Installation of Level Crossings (Concrete Panels)
WIN-RTS-RTM-187	Installation of Level Crossings (STRAIL)
WIN 0132258	Rail Treatment at Level Crossings
Doc 0138351	Rail Asset Management Plan – Level Crossings
Doc 0152351	External Organisation Interface Agreement Register - Level Crossings

2.10.3. Handling and Storage

Level crossing components shall be handled, transported and installed in a manner to prevent damage to the sleepers or any other track components. Level crossing panels shall be lifted using designated lifting points using suitable lifting apparatus.

Level crossing panels shall be stacked on level stable ground as per manufacturer recommendation in such a manner that unacceptable stresses will not be induced in the panels and contact damage between panels is avoided.

2.10.4. Reuse and Disposal

Modification of level crossing approaches, controls or components shall only be conducted after thorough risk assessment has been completed and hazards identified.

The decommissioning and disposal of level crossing equipment and systems shall be controlled and shall consider the following requirements:

- Maintaining safe railroad and level crossing operations during decommissioning and disposal.
- Ensuring that decommissioned equipment is clearly identified as such.
- Preventing inappropriate use of decommissioned equipment prior to disposal.
- Eliminating, as far as is practicable, any public or private hazard associated with decommissioned equipment, with consideration both short and long-term condition; and
- Remove redundant road approaches and reinstate any cess drains to ensure water can drain freely away from the rail ballast/formation.

Decommissioning of a level crossing may involve one or more of the following actions:

- Closing a level crossing.
- Closing a railroad line.
- Deactivation of a level crossing when a railroad line is ‘suspended’ but not closed.
- Replacing equipment with new equipment as an upgrade; and

- Changing the access type of the level crossing (e.g. Closure of a level crossing to vehicular traffic, changing from public crossing to private crossing etc.).

The decommissioning of a level crossing shall involve consultation between the stakeholders of the level crossing, which include the rail and road authorities as well as the community and will comply with the BHPIO Management of Change Procedure.

Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117). All non-reusable level crossing components should be clearly marked and disposed of as soon as practicable after release from track as per Section 2.1.4.

2.11. Bridges and Culverts

2.11.1. Types and Installation

Design and rating of structures shall comply with DESC-000-C-00002 and DESC-000-C-00001 and consider the following documents where applicable:

- AS 5100 Bridge Design Code.
- AS 4799 Installation of Services and Pipelines with railway boundaries.
- AREMA; and
- For other structures: Relevant Australian Standard.

Ballast matting on bridge decks is approved for use as it provides cushioning effect between ballast and concrete bridge decking, reducing ballast attrition.

Replacement bridge and culvert structures shall, as far as is practicable, be installed on the existing track alignment or be installed in such a location as to improve the track alignment. Maintaining or improving track alignment requires that no additional horizontal curves are introduced.

The manufacturer and installer of culvert remediation materials shall ensure that remediated culverts, at a minimum, meet the original culvert strength (as new). In addition, the manufacturer shall demonstrate that any new material meets the requirements for both abrasion and impact resistance for the application.

Major structures such as road and rail bridges should have the location marked on the structure.

In addition to master data, relating to bridge and culvert structures, stored in the 1SAP system, a register providing detailed information regarding all under track structures shall be maintained.

2.11.1.1. Structures Owned by Other Parties

Suitable derailment and crash protection shall be provided to protect structures owned by other persons or organisations that interface with the BHPIO Railroad.

Where a structure owned by another person or organisation is considered to present an unacceptable risk to the safe passage of trains, the following actions should be undertaken:

- Notify the relevant person or organisation in writing requesting appropriate action be taken to reduce the risk to acceptable levels; and
- Consider the need to impose operational restrictions or other means to reduce any immediate risk. If the risk is not addressed satisfactorily, then consideration should be given to reporting the situation to the appropriate regulatory authority for resolution.

2.11.2. Reference Documents

Document Reference / ID	Title / Description
DESC-000-C-00002	WAIO Design Criteria Earthworks and Drainage
DESC-000-C-00001	WAIO Design Criteria Track Design
AS 4799	Installation of Services and Pipelines with Railway Boundaries
SPEC-000-S-00053	WAIO Demolition Works
AS 5100	Bridge Design Code
AREMA Ch10	American Railway Engineering and Maintenance of Way Association – Chapter 10 Structures, Maintenance and Construction
WIN - 0106584	Remove / Replace Handrails DeGrey Bridge
WIN - 0076701	Installation MSA Rail Slider WAH
WIN - 0076709	Verify Common Bridge Type A WAH
WIN - 0076710	Verify Common Bridge Type A
WIN - 0076717	Verify Common Bridge Type D WAH
WIN - 0076718	Verify Common Bridge Type D
WIN - 0076720	Culvert Service
WIN - 0106586	Fastening Bolts on Bridge structures
WIN - 0106589	NDT of Infrastructure
WIN - 0106590	Timber Transom Bridge inspections
WIN - 0106592	Ballast Deck Bridge Inspections
WIN - 0112355	Ballast Pan Hungry Board Replacement

2.11.3. Handling and Storage

Bridge and culvert components shall be handled and stored to ensure that they do not suffer damage or cause damage to other assets.

Spare materials shall be stored in approved warehouses and inventory managed locations.

2.11.4. Reuse and Disposal

Bridge and culvert components will usually be replaced once their useful life has expired. As such bridges and culverts that have been used in track will typically not be reused and will require decommissioning, demolition (as per SPEC-000-S-00053), and disposal.

All non-reusable bridge and culvert components shall be clearly marked and disposed of as soon as practicable after release from track as per Section 2.1.4.

If bridge, and culvert components are removed from track during their useful life, and they have potential for reuse then a thorough structural assessment shall be undertaken by a trained and competent structural engineer and a formal risk assessment be undertaken prior to reuse of the components. Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117).

2.12. Earthworks

2.12.1. Types and Installation

Earthworks shall be designed in accordance with DESC-000-C-00002 and in such a way so as not to risk the integrity of the overlying track construction. DESC-000-C-00001 shall be consulted for track design.

Excavations in the vicinity of rail formation shall not be made within 5m from toe of embankment. Rail Engineering GTS approval is required if this clearance cannot be met.

Design and rating of earthworks and geotechnical structures should where necessary include geotechnical investigation and specialist geotechnical advice of the site and materials.

Earthworks in relation to construction and maintenance of BHPIO Railroad shall adhere to the following:

- Be of suitable stiffness to support the applied static and dynamic loads.
- Be suitably compacted; and
- Be suitably free draining and not subject to seasonal variation.

2.12.2. Handling and Storage

Earthwork materials shall be handled in such a way to avoid contamination and degradation. Vehicles used for handling and transportation shall be clean and free from rubbish and substances which may foul or damage the material. Stockpile lay down areas shall be located and prepared to reduce the risk of contamination from underlying ground or from flooding. Relocation and stock piling of earthwork material shall be minimised as far as is practicable to reduce the risk of contamination and degradation.

2.12.3. Reuse and Disposal

All non-reusable excavated material shall be quarantined from good material to prevent its reuse prior to disposal. Excavated material shall be placed in such a position as to cause the least inconvenience to vehicular traffic and other construction work. Excess material shall be removed from the site and deposited and spread neatly at approved disposal sites.

Topsoil or road base material to be reused shall be stockpiled separately from other material.

Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117).

2.12.4. Reference Documents

Document Reference / ID	Title / Description
DESC-000-C-00002	WAIO Design Criteria Earthworks and Drainage
DESC-000-C-00001	WAIO Design Criteria Track Design
070-C-13421	Embankment Fall Protection - Typical Details
WIN-RTS-RTM-183	Front End Loader Operation
WIN - 0078027	Excavator (Operation of)
Procedure 0149538	Procedure - Rail Control Blast Affecting Rail Corridor Procedure
SPEC-000-R-00009	Under Track Access – Design, Installation and Life of Asset
SPEC-000-C-00105	Earthworks – Civil and Drainage

2.12.5. Blasting Near Rail Corridor

Any blasting near the rail corridor shall comply with the *Rail Control Blast Affecting Rail Corridor* procedure (0149538) and SPEC-000-C-00105.

2.12.6. Under Boring Track

Any under track utility service cables and/or pipelines shall be compliant with the relevant Australian standards for under track service crossings (Including AS4799) and meet the requirements outlined in SPEC-000-R-00009, whichever is the more stringent.

2.13. Access Road

2.13.1. Types and Installation

The BHPIO Railroad access road shall be of asphalt or graded earth construction. It shall provide vehicular access to the track for maintenance purposes for light and heavy vehicles. The access road shall provide sufficient width for bidirectional travel, including appropriate signage. Where bi-directional travel is not possible then appropriate traffic management signage shall be installed to manage traffic flow. Relevant Australian Standards shall be complied with to achieve these requirements.

The access road shall be maintained to provide a surface suitable for light off-road vehicles travelling at 80km/h. Where this speed is not possible due to geography or structures then appropriate speed restrictions shall be implemented and communicated via appropriate signage.

Where bridges across waterways are not provided for vehicular access then suitable ford crossings shall be installed with water depth markers visible to approaching vehicles.

Access points to the BHPIO Railroad for hi-rail vehicles shall be provided off the main access road. The minimum acceptable form of hi-rail access will be precast concrete crossing panels and designed to enable heavy hi-rail vehicles (mobile flashbutt welding machines, ultrasonic car, and hi-rail truck) to drive onto and off the track. The minimum width shall be 6m.

2.13.2. Reference Documents

Document Reference / ID	Title / Description
DESC-000-C-00002	Design Criteria Earthworks and Drainage
000-C-12012	Roads – Typical Sections
000-C-12013	Road Furniture – Typical Details
000-C-12085	Rail Embankment and Access Track – Typical Sections
SPEC-000-C-12009	Unsealed Access Roads
WIN-RTS-RTM-149	Daily Access Road Inspections
WIN-RTS-RTM-150	6 Monthly Access Road Inspections
WIN - 0106581	Inspecting Access Roads

2.14. Signs

This Section applies to permanent and temporary infrastructure operating signs that provide information and directions for BHPIO Railroad users. These include signs for the following:

- Permanent speed restrictions including curves and turnouts.

- Temporary speed restrictions including track, work site, warning and caution signs.
- Protection including worksites and obstructions.
- Warning signs including whistle signs and advance warning signs.
- Change of operations system or operational parameters (e.g. RTS, train order, radio channel, station/yard limits).
- Structure, equipment and location identification signs including kilometre posts; and
- Track monuments.

It should be noted that this does not include road signage.

A register of all permanent operational signs shall be maintained, containing details such as sign locations, type and purpose.

2.14.1. Types and Installation

All signs should be constructed in line with the Australian Standards listed below. In addition, general requirements and recommendations for design and placement are as follows:

Trackside signs:

- Shall be positioned to be clearly visible to the train crew of an approaching movement during day and night conditions. Sign positioning shall be such that no obstruction is permitted when viewed from the driver's normal operating position.
- Where practicable, shall be erected on the left side of the track in the direction of increasing kilometres.
- Shall use retroreflective material.
- May be erected independently or be fixed to other appropriate infrastructure.
- Shall be placed in positions of low hazard.
- Shall have reverse sides that are neutral in appearance.
- May have their meaning qualified by the attachment of qualification plates.
- May have their shape modified to meet clearance limitations; and
- Should have a border around their perimeter to improve their visibility.

The following also apply:

- Additional trackside signs designed for specific local conditions may be erected.
- Track monuments shall be designed and installed in accordance with SPEC-000-C-00117; and
- Kilometre signs should be located at every kilometre, positioned on both sides of dual track and on single track sections they should be visible from the track and from the access road. The kilometre posts indicate the distance from a set point and are used to identify a specific location on the section of line and track. Note: Markings on the rail also indicate 100m intervals of track.

2.14.2. Reference Documents

Document Reference / ID	Title / Description
AS 4292	Railway Safety Management
AS 1742.7	Manual of uniform traffic control devices

Document Reference / ID	Title / Description
AS 1743	Road Signs – Specifications
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements
000-C-12058	Trackwork – Location Signs and Markers Layout and Details
000-C-12059	Trackwork – Track Monument
CD - 0168180	RRB MANUAL NSSM Network Signals and Signs Manual
000-C-12013	Road Furniture

2.14.3. Handling and Storage

Signs shall be handled, transported and stored in a manner to prevent damage to the signs.

2.14.4. Reuse and Disposal

Signs that are deemed inadequate, whether by specification, damage or visibility, shall be removed and if required replaced. All signs shall be segregated into one of the following categories:

- Reusable; or
- Disposal.

Signs that have the potential for reuse shall be marked in such a manner that the reuse potential is clear and unambiguous. Any assets identified for reuse shall be checked against construction standards (SPEC-000-C-00117).

All non-reusable signs and associated components shall be clearly marked and disposed of as soon as practicable after release from removal.

2.15. Clearances

Clearances to structures and to adjacent track, including between primary and divergent track, shall be maintained as per DESC-000-C-00001 and clearance drawings documented below. The standard minimum clearance to all structures on the mainline including signals shall be 4876mm either side of track centreline.

Where a guard rail has been fitted to provide protection to a structure in the event of a derailment the structure outline should be widened to accommodate derailed rolling stock running against the guard rail.

If a vehicle does not conform to the dimensions stated in the referenced documents, then the traffic may be accepted subject to the satisfactory completion of a risk assessment which shows that the vehicle will pass all track side structures on the route. In accepting such traffic, it is recognised that it is ‘exceptional’ and can only travel under conditions of passage dictated by the out of gauge loading procedure documented in the 0168104 - RRB RULE RT01 Preparation and Movement of Rail Traffic.

Maintenance activities such as rail drops and pickups shall comply with clearance requirements of drawing 073-C-12573 as they could encroach in the kinematic outline of dual wheel hi rail vehicles.

Any introduction of new (owned or contracted) rail mounted equipment shall adhere to SPEC-076-G-00005 Minimum Performance Standards for On-Track Vehicles.

2.15.1. Reference Documents

Document Reference / ID	Title / Description
076-M-01285	Rolling Stock Handbook Index Page

Document Reference / ID	Title / Description
076-M-01287	Load out Tunnel Clearance Diagrams
076-C-12000	Kinematic Envelope and Static Outline
003-M-12003	Car Dumpers – Locomotive and Ore Car Clearance
000-M-00067	Railway Rolling Stock Line Clearance Diagram
DESC-000-C-00001	Design Criteria Track Design
CD - 0168104	RRB RULE RT01 Preparation and Movement of Rail Traffic
073-C-12573	Minimum Rail Clearance for Dual Tyre Rail Vehicles
SPEC-076-G-00005	Minimum Performance Standards for On-Track Vehicles

2.16. Commissioning

Requirements concerning the confirmation of asset suitability when opening to rail traffic following maintenance activities are documented in Section 3.5. Commissioning major projects shall be carried out in compliance with the relevant project specifications. The content that follows provides guidance to the asset maintenance owner in the situation of receiving newly commissioned assets.

When accepting newly commissioned assets the following shall be considered by the receiving party:

- Suitable and acceptable updates to the 1SAP functional location structure to reflect the new or changed asset have been provided.
- Any required maintenance documentation has been provided and attached to the relevant functional locations in 1SAP.
- Suitable early maintenance has been carried out on the asset, or suitable plans for the execution of early maintenance has been communicated and accepted by the Track and Signals department.
- Any additional required maintenance equipment has been provided and is fit for purpose.
- Asset walkthrough has been completed by a trained and competent inspector as defined in Section 3.1.4; and
- Checks made to confirm that the asset complies with maintenance requirements specified in this Code of Practice.

If the inspections identify any non-conformance with the standards, the opening speed shall be reduced in accordance with the appropriate guidelines specified within this Code of Practice. The track shall not be opened until the appropriate checks confirming compliance have been completed and documented.

The track may be opened with minor non-conformances if the risks of doing so are formally assessed and documented and approval is granted by the Rail Engineering Manager.

2.16.1. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-C-00117	WAIO Standards – Rail Track Work – Tracklaying Construction Requirements

2.17. Asset Protection

Asset protection systems utilised on the BHPIO Railroad include:

- Derailers.
- Catchpoints.
- Wheel and bearing monitors.
- Dragging equipment detectors.
- Rail temperature detectors.
- Weighbridges.
- Stream flow detectors.
- Level crossing warning and barricading systems; and
- Video imagery systems.

Some asset protection systems are designed to protect the assets from rolling stock failure rather than track asset failure and are managed and maintained by departments other than track maintenance. These protection systems, however, typically reside on the track asset and need to be considered when carrying out track maintenance works.

Design and approval of the installation of asset protection systems shall consider the ease of maintenance of the track.

Asset protection systems that form part of the track structure such as derailers and catchpoints shall be managed and maintained by the Track Maintenance department.

2.17.1. Protection from Unauthorised Rolling Stock Movements

Where there is a risk of an unauthorised movement of rolling stock fouling a main line or entering an exclusion area then a physical method of diverting, retarding, restraining or derailing the unauthorised movement shall be installed.

Unauthorised movements of rolling stock include:

- Uncontrolled movements of rolling stock; and
- Controlled movements of rolling stock exceeding the limit of their movement authority.

The preferred method of controlling unauthorised movements is to divert the movement to an alternative route through system design solutions such as flank protection or other non-impact solutions.

Derailment of an unauthorised movement should be considered as a last resort only.

DESC-073-R-00001 sets out the requirements and design principles required to establish the minimum level of protection against unauthorised rolling stock movements within the BHPIO Rail network.

2.17.1.1. Catchpoints

A set of points, the normal position of which provides an open trap to a movement in the facing direction resulting in an enforced derailment thus avoiding a potential collision between movements. When the catchpoints are closed, they enable authorised facing and trailing moves to take place.

Catchpoints are used for the protection of running line movements from shunting movements or from unauthorised movements of loose wagons or stored rolling stock or track maintenance machines on other lines, sidings or spurs.

Catchpoints have several different configurations and are more effective in derailing rolling stock than derailers or derailers with crowders.

2.17.1.2. Derailers or Derailers with Crowders

A derailer is a two-position mechanical device mounted onto sleepers, bearers, concrete pads or ties. When seated over the rail head in the 'derail position' it will deflect a low-speed movement off the rails resulting in an enforced derailment thus avoiding a potential collision between movements. When swung away from the railhead the derailer enables authorised facing and trailing movements to take place.

When a derailer is combined with a 'wheel crowder' it is more effective in derailing rolling stock.

A derailer or derailer with crowder used on the BHPIO rail network may be Uni-directional or Bi-directional in design.

2.17.1.2.1. Derailer or derailer with crowder restrictions

Derailers or derailers with crowders must not be installed:

- On the main line.
- On the inside of curved track.
- Where the calculated speed and/or the mass of the unauthorised train movement renders the derailer or derailer with crowder ineffective; or
- For the protection of a running line unless the requirements of Section 4.3.2 of AS-7724:2020 are met.

2.17.1.3. Temporary Derailers

Temporary or portable derailer used in the BHPIO rail network shall be defined as a derailer that clamps directly to the rail as opposed to derailers that are mounted to sleepers and bearers.

Temporary or portable derailers shall only be used in the following situations:

- The temporary relocation of Ownership Transfer Points (OTP's).
- Construction areas to protect personal from unauthorised movements entering the construction zone.
- Where an existing permanent derailer is out or service; or
- Where a safety concern has been identified and the installation of a derail is the appropriate control. They shall only be used until a permanent derailer can be installed.

Temporary or portable derailers shall not be used for long term applications and must be removed from service as soon as practicable.

2.17.2. Guard Rails

Guard rails are not mandatory however may be used on the BHPIO Railroad wherever there is a risk of a derailed train causing damage to a structure, or where the presence of a structure or other hazard would cause the consequence of a derailment to be greater. Guard rails, when installed, shall comply with the following requirements:

- Guard rails shall be AS 68 kg/m rail or other equivalent sections with rail head wear not exceeding 40%.
- Both sides of the track shall be protected, unless the identified hazard is only on one side of the track, where a single guard rail may be installed for protection from that hazard.
- The top of the guard rail shall remain clear of the loading gauge, preferably be at the level of the adjacent running rail surface, or below it by no more than 50 mm.
- The working face of the guard rail that comes into contact with derailed wheels should be approximately 250 mm from the gauge face of the running rail and be located to keep derailed wheels on the sleepers and to avoid rolling stock impacts with structures.

- Guard rails should extend 10m past the end of the structure or any other hazard being protected.
- Guard rails should be fastened to at least every second sleeper and preferably to every sleeper.
- Guard rail lengths shall be joined using 4-hole fishplate joints (or equivalent) as a minimum; and
- The ends of the guard rails shall be:
    - flared away from the running rails.
    - vee shaped where there are pairs of guard rails between the running rails; and
    - fastened to every sleeper.

2.17.3. Weighbridges and Asset Protection Sites

Weighbridges are located at TLOs and on the mainline (currently at 47km and 416km marks). There are numerous asset protection sites, consisting of at least HW and/or HBDs. Weighbridge and asset protection locations have data and power cables that run underground and adjacent to the track, and within / around TLO structures. Weighbridge load cells are generally bolt-on units (with glued-on covers at TLO sites). Adequate clearance beneath the weighbridge rails must be maintained (along the instrumented section of the tracks) to ensure accurate readings. Adequate drainage must be maintained in weighbridge and asset protection sites at all times as equipment modules are not designed to be submerged in water.

Track maintenance personnel are to be aware of cable locations and equipment vulnerabilities outlined above.

Weighbridges and asset protection sites are susceptible to damage from track maintenance activities and equipment. Rail Communications requires notification in order to provide labour and support for equipment preparation prior to track maintenance and subsequent re-calibration. Such track maintenance activities include:

- Works using tampers, regulators, and grinders.
- Hot work (within 1m of sensors).
- IRJ replacement within close proximity.
- Ballast, sleeper or formation works in the area; and
- Re-railing, which requires re-installation of weighbridge load cells and covers.

There are specific provisions for Track Maintenance activities at the 47km Asset Protection Site in the applicable TMAN (referenced below).

Some asset protection sensing equipment is susceptible to issues arising from track movement associated with repeated hand-tamping. Machine tamping is the preferred method after proper removal of such equipment.

Removal and re-calibration of weighbridge or asset protection components generally shall be coordinated with Rail Communications and the equipment vendor.

2.17.4. Reference Documents

Document Reference / ID	Title / Description
AS-7724	Unauthorized Movement Protection – Operational Requirements
SPEC-000-C-12005	Design, Manufacture and Supply of Turnouts, Catchpoints and Insulated Rail Joints
SPEC-000-C-12006	Design, Manufacture and Supply of Buffer Stop Specification
SPEC-000-C-12004	Design, Manufacture and Supply Heavy Haul Railway Derailer Specification

Document Reference / ID	Title / Description
TMAN-073-C-12003	47km Asset Protection Site Hollow Sleepers & Track Maintenance
TMAN-000-C-12006	Western Cullen Hayes Uni-directional Derailer and Crowder Assembly
TMAN-000-R-00002	Western Cullen Hayes Bi-directional Derailer and Crowder Assembly
TMAN-073-R-00015	Siemens D150 Derail & C150 Crowder. Mk I and Mk II
Doc 0147644	Western Cullen Hayes Derailer Procurement Reference Guide
0099624	Rail Control Asset Protection Systems
0128613	PMI – Mech Insp 47km Supersite Track

3. Inspections

3.1. Visual Track Inspection

3.1.1. Inspection Purpose

The purpose of visual track inspections is to check the general condition of all aspects of the rail corridor to ensure safe passage of trains. The person executing the inspection should keep a lookout for track defects and conditions (i.e. indicators of a defect) that may affect the integrity of the track structure.

These inspections may be carried out from an on-rail vehicle traveling at a speed consistent with the scope of the inspection, or by walking. Minor defects that are identified, such as missing bolts or rail flow at IRJs, shall be rectified by the person executing the inspection if safe to do so. If not safe to do so, or the person is unable to do so, a notification to carry out the repairs shall be raised.

The conditions that should be considered and noted when observed include the following described in Table 3-1:

Table 3-1 Conditions to be Observed during Track Inspection

RAIL AND WELDED JOINTS	
Broken rails and rail welds	Unusual vehicle tracking patterns
Rail and rail weld deformations and discontinuities	Rail corrugation
Wheel burns	Rail crippling
Damage to rail surface or section	Other obvious indications of defects (e.g. Bleeding)
Unusual patterns of gauge face contact	Other surface defects
NON-WELDED JOINTS (INCLUDING IRJs)	
Broken, missing or loose bolts	Rail end batter
Broken plates	Insulation breakdown
Metal flow across joint	Track circuit bond wire damage
Vertical deformation	Other obvious defects or missing components
RAIL WEAR	
High wear rates (e.g. Presence of filings)	Other unusual and obvious wear patterns and defects indicating for example poor vehicle tracking, sharp points in curves or excess/deficiency in track superelevation
Excessive top or side rail wear	

GUARD RAILS	
Missing or ineffective rail/sleeper fastenings	Obvious damage to components
Lack of guard rail continuity	
BALLAST	
Track sections with inadequate ballast profile	Heaped ballast or gaps at sleeper ends that indicate lateral track movement, or a migration of ballast away from the track
Track sections where the ballast profile may interfere with the operation of infrastructure (e.g. Signals or switches) or rolling stock	Accelerated loss of track geometry (especially following unusual weather events) that may indicate poor ballast quality
Bog holes or wet spots	Other obvious defects that may affect track stability and support
Indications of poor sleeper support by ballast (e.g. Cracking of sleepers and bearers, excessive vertical sleeper movement)	Whitening of the ballast indicating movement of the ballast and rounding of angular edges
Fines contamination	
SLEEPERS AND FASTENINGS	
Damaged, split, cracked, broken or missing components	Indications of incorrect rail cant
Indications of lateral movement of fastenings and sleeper plates on timber sleepers	Abnormal deterioration of sleepers and fastening condition; other obvious defects that may affect the track structural integrity or stability
Indication of sleeper movement (e.g. Bunching, skewing)	Missing or damaged fastenings
TURNOUTS	
Broken crossings, switch blades, or rails	Wheel marks which indicate incorrect wheel/rail interaction
Missing components	Rail creep which may lead to displacement of components and rail alignment problems
Damage to any component that does not allow it to perform its intended function including switch operating equipment	Rail pulling including at the point and splice rails of fabricated crossings
Flange way and other obstructions	Other obvious defects that may affect continuity of support and direction to rolling stock
Track geometry defects	Broken crossings, switch blades, or rails

LATERAL STABILITY	
Lateral misalignments including “kicks” in tangent track	Track movement, indicated by for example gaps between sleepers and ballast (laterally and longitudinally)
Curved track sections with sharp or flat curvature	Heaped ballast
Rail breaks (i.e. Excessive local tensile rail stresses contributing to pull-rail apart)	Skewed sleepers
Indications of incorrect rail stress, for example twists and misalignments in the rail at temperatures well below design neutral, which may indicate the rail is in compression	Other obvious defects or conditions that may affect lateral track stability
Marks on the rail indicating longitudinal movement of the rail (creep) through the fastening assemblies	
GEOMETRY	
Track geometry defects including those that may indicate problems with the underlying sub-structure	Obvious variations in track alignment that may, for example, affect clearances or track stability
Locations where track geometry has deteriorated notably since last inspection	Alignment defects and signs of movement that could cause excessive vibration of track-mounted signalling equipment
Locations where the geometry is inconsistent with the track either side (e.g. A sudden change in curve radius)	Alignment defects and signs of movement that could affect the operation and/or reliability of switches, crossings and associated equipment
Evidence of recent or current movement (including voids at sleeper end)	Other obvious defects that may affect track stability and support
Unusual wear patterns on the rail	Indications of cyclic geometry (including signs of hunting rolling stock)
LEVEL CROSSINGS	
Any obstructions to flangeway clearances	Abnormal road surface conditions
Poor track geometry on approaches and through level crossings	Damage to level crossing components
All warning signs and devices are installed and operational as required by the level crossing design, and its ALCAM assessment	
STRUCTURES	
Changes in the alignment of the structure (e.g. As indicated by track geometry error or movement in vertical or horizontal alignment)	Other obvious defects that may affect the structure’s integrity

Component or structural member damage, for example as caused by derailment, collision, dragging equipment on rolling stock or vandalism	Damage or subsidence of safety handrails associated with structures and/or embankments
EARTHWORKS	
Indications of recent movement including slippage, slumping, settlement or heaving	Earthwork scour and/or erosion including narrow formation leading to loss of ballast and undercutting of the toe of embankments and cuttings by water or wind
Fissures and cracks in formation or earth batters	Water seepage from embankments and cuttings
Rock, earth, or other debris falling on or near the track	Damage to embankments or cuttings including that caused by construction or vehicle access
Loss of track geometry	Conditions that may cause future slip, scour, slump, settlement including burning off or clearing of steep embankments and cuttings
Track subsidence due to ground movements	Any other occurrence likely to impact on the stability of earthworks
SIGNS	
Damaged, missing or unreadable signs	Any location where sight distance is deficient or the view by the train crew of the sign or signal may be obscured
CLEARANCES	
Track obstructions	Evidence of recent or current movement
Changes in track or structure location since previous inspection	Fouling point markers are not visible, conspicuous or performing the function intended
Visible markings or damage to structures	Evidence of recent or current movement of dropped long welded rail
Inadequate horizontal and vertical alignment past or through structures	Other obvious defects that may affect clearances

VEGETATION	
Vegetation growing in the track ballast	Vegetation growing that obstructs visibility of level crossings
Vegetation growing that obstructs visibility of signs	
FIRE HAZARDS	
High risk fire locations including presence of combustible rubbish and vegetation	Indication of unreported fires
Infringement on firebreaks of combustible materials	
DRAINAGE	
Scour	Indications of floods overtopping a structure
Blockage or partial blockage of the waterway or track drain due to debris, rubbish or silt	Culvert/drain damage or collapse
Damage to waterways, drains or cesses by construction or vehicle access	
ASSET PROTECTION	
Damaged or missing asset protection systems including derailers, guard rails, dragging equipment detectors, wheel and bearing monitors, cold rail detectors	Signs of potential failure of asset protection systems

3.1.2. Inspection Frequency

Table 3-2 Visual Track Inspection Frequency

Inspection Type	Track Category 1 NML-WT* NMLC-WT	Track Category 1	Track Category 2	Track Category 3
Visual Patrol Track Inspection	7 days	14 days	14 days	6 months

* Yandi junction through to Port Hedland

Where multiple tracks run parallel, with track centres ≤ 6m and local factors that allow for the adjacent track to be viewed without obstruction, then running on one track may constitute an inspection of both tracks however the speed of the inspection shall be adjusted appropriately to enable the inspector to observe conditions on both tracks.

3.1.2.1. Missed Inspections

When inspection cycles are missed the following shall occur for Category 1 and 2 track excluding NML-WT and NMLC-WT.

After 14 days without Inspection

- Inspect all P2* defects OR apply 45 TSR.

After 16 days without Inspection

- Apply 45 TSR
- Inspection all P2* defects OR apply 25 TSR.

After 21 days without Inspection

- Close Track

**P2 defects are as defined in Document 0143489 – Defect Management Procedure.*

TSR's shall be applied by the area Rail Execution Track Maintenance teams on advice from the Asset Integrity team and shall remain in place until the relevant section of track has been inspected.

NML-WT & NMLC-WT will continue to be inspected on a 7-day frequency as shown in Section 3.1.2.

3.1.3. Reference Documents

Document Reference / ID	Title / Description
WIN-RTS-RTM-096	Hi Rail (Operation of)
0143489	Defect Management Procedure

3.1.4. Inspector Qualifications

The person carrying out the inspection shall:

- Be as a minimum qualified and deemed competent of the following training modules:
  - TLIB3100 Visually inspect track infrastructure.
  - TLIB2091 Measure and record track geometry.
  - TLIB3099 Examine track infrastructure.
  - TLIB3094 Check and repair track geometry; and
  - TLIB3095 Check and repair points and crossings.
- Be preferably fully qualified to Cert 3 Rail Infrastructure level.
- Be competent in identifying track defects.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice & the relevant reference documents herein.

3.1.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.2. Detailed Track Inspection

3.2.1. Inspection Purpose

Detailed track inspections shall be carried out on foot and may typically require measurement or testing equipment. Detailed track inspections may be required in the following situations:

- A defect is identified during visual track inspection that requires further assessment.
- A defect is identified during other inspections that requires assessment.
- Unusual deterioration is observed that requires further investigation.
- A cluster of defects is identified that may warrant an increased defect response code.
- External factors are identified that may require a change in a defect response code.
- Defects are suspected but cannot be confirmed visually and require further testing.
- Planning for maintenance activities.
- Planning for renewal activities.
- Scoping of track upgrades.
- Monitoring of known problem sites.
- Monitoring of geometry defect sites if the Track Condition Monitoring Vehicle inspections are not carried out within the required timeframes; and
- As part of a track hand back procedure following maintenance or a significant event.

Detailed track inspections shall be carried out as necessary where, for any reason (e.g. slips, floods, earthquakes, driver reports, Track Condition Monitoring Vehicle reports, irregularity reports etc.), it is suspected that changes in geometry may have occurred. Sites with a history of geometry irregularities such as cyclic geometry shall be inspected in detail if any change in geometry is observed.

Where a higher than expected deterioration in gauge has been detected between inspections the track shall be subjected to a detailed inspection of sleeper effectiveness and appropriate actions taken.

Detailed inspections of the rail may be undertaken by use of ultrasonic technology, as covered in Section 3.7, though other tests may also be used in certain circumstances including but not limited to:

- Magnetic particle testing; and
- Dye penetrant testing.

3.2.2. Inspection Frequency

Table 3-3 Detailed Track Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Detailed Track Inspection	As required	As required	As required

3.2.3. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4; and
- Be trained and competent in the use of any required measurement or test equipment.

3.2.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.3. Track Condition Monitoring Vehicle Inspection

3.3.1. Inspection Purpose

Track Condition Monitoring Vehicle (TCMV) inspections shall be carried out for the purpose of monitoring the condition of the track geometry, rail wear and rail profile. With full coverage of the Category 1 and Category 2 tracks, the data from the TCMV can be used to provide quantifiable and comparable information regarding the condition of the track across the BHPIO Railroad.

Inspection intervals shall be based on rail haulage rates and be expressed in million gross tonnes (MGT) with a limiting time-based interval for track with low haulage rates. Inspection intervals will therefore vary between different sections of the rail network.

Track geometry, rail profile and rail wear shall be monitored to ensure that sufficient time is provided to plan and execute maintenance works prior to defect limits being exceeded, as per Section 4.

Readings from different geometry measurement devices must be considered in terms of the load applied to the track by the device. Heavier loading may result in larger geometry deviations being observed.

The Superintendent of Condition Monitoring is responsible for ensuring that:

- The TCMV data collection systems are adequately calibrated and serviced.
- Suitable documented procedures are in place for analysis of all recorded data.
- Returned data is clearly organised and accessible for stakeholder use.
- Appropriate procedures are in place for the circulation of information for inspection and rectification work notification; and
- Recorded data is processed and made available in a suitable database for analysis.

3.3.2. Inspection Frequency

Table 3-4 TCMV Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Track Condition Monitoring Vehicle (TCMV) Inspection	25MGT or 12 weeks (whichever comes first)	25MGT or 26 weeks (whichever comes first)	N/A

In Track Category One areas where the above inspection frequencies are not adhered to, the following shall be implemented:

- 45 km/h TSR applied after 37 MGT or 12 weeks (whichever occurs first) have passed since the last TCMV inspection; and
- 25 km/h TSR applied after 50 MGT have passed since the last TCMV inspection.

In Track Category Two areas where the above inspection frequencies are not adhered to, the following shall be implemented:

- 25 km/h TSR applied after 37 MGT or 26 weeks (whichever occurs first) have passed since the last TCMV inspection; and
- 10 km/h TSR applied after 50 MGT have passed since the last TCMV inspection.

Where a TSR is required, the Track Condition Monitoring Lead shall advise the local Track Maintenance team as soon as practicable. Where a TSR cannot be put in place immediately, it shall be installed within 24 hours.

Note that without input from the Instrumented Ore Cars (IOC), TCMV geometry inspections for Track Category 1 areas shall be carried out every 25MGT or 12 weeks, whichever comes first.

Where TCMV inspection frequencies for geometry and rail profile cannot be adhered to then alternative form of inspection(s) shall be established. This shall make use of the data from the last TCMV run to provide locations of critical areas that require prioritisation and consider areas at risk of cyclic geometry development.
Additionally for the rail profile these alternative inspections shall focus in detail on high-risk areas with tight curves and steep gradient to monitor for and report any rail profile defects.

Alternative forms of inspection may include, but not be limited to, visual inspections, use of hi-rail vehicles and survey trolleys as agreed by the Track Inspector, Supervisor, Reliability Engineer and Superintendent(s).

If the inspection frequencies above for rail wear cannot be adhered to then other sources of rail wear data shall be sought and used. These sources may come from the continuous ultrasonic rail defect identification inspections for example. Limitations of other data sources in terms of ability to record both top and side wear, and rail head area loss shall be considered and high-risk areas with tight curves and steep gradient shall have visual rail wear inspections carried out.

3.3.3. Inspector Qualifications

The person operating the systems on board the Track Condition Monitoring Vehicle shall be suitably trained and competent.

The data from the track condition monitoring vehicle shall be reviewed by a trained, competent and suitably qualified person in the Asset Integrity team, as identified by the Superintendent of Condition Monitoring.

3.3.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

Data gathered during the inspection shall be kept for a minimum of two years, however depending on the data type, should be kept for significantly longer to enable condition monitoring and deterioration tracking.

Beyond the two-year period of all data retention, where applicable, the following minimum requirements apply for:

- Total data retention period; and
- Maximum period between stored data sets.

Table 3-5 TCMV Data Retention Periods

Data Type	Maximum Period Between Stored Data Sets	Data Retention Period
Geometry	26 Weeks	10 Years
Rail Profile	26 Weeks	10 Years
Rail Wear	26 Weeks	15 Years
Driver Eye View Video Imagery	1 Year	5 Years
Track Defect Imagery	N/A	2 Years
All Defect Types and Locations	N/A	10 Years

3.4. Instrumented Ore Car Inspection

3.4.1. Inspection Purpose

The track shall be inspected by means of un-manned instrumented ore cars that report dynamic movement of the ore car in response to the track (via displacement transducers mounted on the springs and accelerometers mounted on the side frame). Instrumented ore cars shall measure the following parameters:

- Bounce (average suspension travel of the left and right spring nests).
- Body rock (difference in suspension travel of the left and right spring nests).
- Suspension travel (maximum suspension travel of the ore car); and
- Vertical acceleration (vertical acceleration of the un-sprung mass, measured on the side frame).

The data collected by the instrumented ore car inspections should identify track locations where the ore cars do not run smoothly, due to:

- Larger rail surface defects such as spalls.
- Poor track geometry; and
- Pumping track including at welded and non-welded rail joints.

Data generated by the IOCs shall be processed and made available in a suitable database for analysis. Recordings exceeding thresholds as detailed in Section 4.2.6 shall be analysed and detailed visual inspections initiated.

The severity of the response recorded by the instrumented ore cars is dependent on the speed at which the ore car is travelling at the time of the measurement. As such the raw data shall be corrected for speed to normalise the results to the typical speed for the track area.

Consideration should also be given to the characteristics of different bogie and spring types. Instrumentation should be attached to a representative sample of the main bogie and spring types in operation.

3.4.2. Inspection Frequency

Table 3-6 IOC Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Instrumented Ore Car (IOC) Inspection	2 days	N/A	N/A

3.4.3. Documentation

Defects identified during IOC inspections shall be inspected, confirmed and appropriate actions put in place through the use of 1SAP.

Defect data shall be retained for a minimum of 10 years.

3.5. Track Work Hand Back and Quality Inspection

3.5.1. Inspection Purpose

Track work hand back and quality inspections should be carried out to ensure that the track is handed back to operations in a fit for purpose state, and to facilitate continual improvement in the quality of maintenance works executed. This will be achieved by means of post work quality checks by both the work executor and by impartial inspectors.

3.5.1.1. Track Work Hand Back Inspection

Prior to the hand back of maintenance sites to rail operations the person in charge of the work shall carry out a visual inspection of the site to ensure that all works have been completed to a satisfactory standard that enables the safe passage of rolling stock.

For major maintenance works involving renewal and/or multiple maintenance activities then the relevant procedure for track hand back should be followed. Refer to the Track Certification Form (No. 0125769). The person initiating this form shall as a minimum meet the qualification requirements as outlined in section 3.1.4 of this CoP.

3.5.1.2. Reference Documents

Document Reference / ID	Title / Description
0125769	Track Certification Form
0160521	Track Handover Certificate
0160520	Track Verification Form

3.5.1.3. Track Work Quality Inspection

Track work quality inspections should be carried out by an impartial inspector who was not involved in the execution of the work. The inspector should provide to the executing work group, track maintenance supervisor and track maintenance area superintendent, information regarding:

- Good work practices observed.
- Good work finishes observed.
- Good housekeeping.
- Defects not rectified during maintenance works.
- Defects introduced during maintenance works.
- Areas for improvement; and
- Learning from the task execution.

The information provided by these inspections should include some or all of the following:

- Photos of completed works.
- Written feedback; and
- Measurements.

Track work quality inspections shall be carried out on foot and may be completed during visual track inspections. The person completing the inspection shall have with them the information from 1SAP regarding the works completed and shall restrict their feedback to these works only.

3.5.2. Inspection Frequency

Table 3-7 Handover & Quality Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Track Work Handover Inspection	Prior to track hand back	Prior to track hand back	Prior to track hand back
Track Work Quality Inspection	Within 7 days of work completion	Within 7 days of work completion	Within 7 days of work completion

3.5.3. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4,
- Be competent in track hand back procedures (Hand back Inspection); and
- Be impartial from the execution of the completed maintenance works (Track Work Quality Inspection).

3.5.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

For major maintenance works where detailed hand back and other documentation is required then completed, approved and signed documentation shall be uploaded to 1SAP.

3.6. Visual Rail Wear Inspection

3.6.1. Inspection Purpose

The purpose of visual rail wear inspections is to identify locations where rail is approaching wear limits, allowing sufficient time to plan and execute maintenance works prior to limits being exceeded.

Visual rail wear inspections shall be carried out by a walking inspection in locations where mechanised rail wear inspections do not occur (such as in yards), or have not occurred within the required timeframes (for category 1 and 2 track), to confirm that the rail is in suitable condition for the safe passage of trains.

Visual rail wear inspections shall involve measurements being taken at a minimum of three locations on a given track with a maximum spacing between measurement locations of:

- 500m on tangent track and curves ≥ 900m radius.
- 100m on curves < 900m radius.

At each measurement location the following shall be recorded for both rails:

- Rail height/Top wear.
- Side wear; and
- Unusual wear patterns and defects.

3.6.2. Inspection Frequency

Table 3-8 Visual Rail Wear Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Visual Rail Wear Inspection	Validation or As Required	Validation or As Required	12 months

For curves < 900m radius on high-traffic tracks, high wear rates are likely. As such, these locations shall be treated as special locations and shall be inspected more frequently once rail wear is within 5mm of the limit thresholds set out in Section 4.3 for top, side or head area wear. The inspection frequency shall be determined based upon the average wear experienced during the previous 12-month period. The wear experienced should be calculated using data from the previous inspection. The following is an example of wear rate calculation and application of the inspection frequency criteria:

Example rail wear for curve with radius < 900m and rail height limit of 172mm:

Rail height measured today = 176 mm

Rail height measured 12 months prior = 179 mm

Annual top wear rate= 3 mm

Next visual rail height inspection required in 4 months. Rerail should be planned to occur within the next 15 months, prior to rail height reducing to 172mm.

Table 3-9 Visual Rail Wear Inspection within 5mm of Wear Limits Frequency

Wear During Previous 12 Months (Annual Wear Rate)	Inspection Frequency
≤ 1mm	12 months
2mm	6 months
3mm	4 months
≥ 4mm	2 months

If wear rates appear to be accelerating, or if ultrasonic testing of the rail for internal defects is difficult due to poor rail surface condition, then inspection frequencies shall be increased to a suitable level as deemed by the Inspector. Increased rail grinding shall also be considered where surface conditions are poor.

Note that locations where high wear rates (>4mm/year) are experienced then consideration should be given to scheduling rerail on a periodic basis.

3.6.3. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4, and
- Be competent in the use of rail wear measurement tools.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.6.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

Areas of track approaching wear limits shall be recorded and all items specified in Section 3.6.1 shall be documented to enable subsequent inspections to be scheduled as per Table 3-9.

3.7. Ultrasonic Rail Inspection

3.7.1. Inspection Purpose

Ultrasonic rail inspections shall be carried out for the purposes of identifying internal and surface defects to enable their removal to be scheduled in accordance with Section 4. Inspection intervals shall be based on rail haulage rates and be expressed in million gross tonnes (MGT). Inspection intervals will therefore vary between different sections of the rail network.

Continuous ultrasonic rail inspections shall be carried out using a rail-mounted vehicle in compliance with relevant standards and specifications as listed in Section 3.7.2.

Manual non-destructive testing shall be undertaken during continuous ultrasonic rail defect identification inspection for the following reasons:

- To confirm suspected defects indicated by the continuous ultrasonic inspection.
- To confirm the type, size and location of the internal rail defect.
- Where there are suspected defects as found by visual inspection; and
- When known defects are due to be re-inspected and reassessed.

Manual testing may also be necessary when the condition of the rail is such that testing from a rail- mounted vehicle is not possible.

The configuration of the ultrasonic testing system, including the number and configuration of the ultrasonic transducers, shall be determined based on the defect types to be detected. Details of defect types which are known to occur in the BHPIO Railroad are documented in Procedure 0131834.

The configuration of ultrasonic transducers and testing methodology is included in Procedure 0131834.

It is important that all rail is tested for defects to mitigate the risk of rail breaks. As such, where testing is not possible within the required timeframes due to either track access problems or poor rail surface conditions, the untested location shall have further controls implemented.

Track sections with > 7.5 MGT since the last ultrasonic inspection shall have a 25 km/h TSR applied.

Track sections with > 10 MGT since the last ultrasonic inspection shall be closed until inspected.

TSR's and track closures shall be applied by the track maintenance area supervisor on advice from the Track Condition Monitoring team, and shall remain in place until the relevant section of track has been appropriately tested.

The rail flaw detection vehicle (RFDV) operator shall advise the Supervisor Track Integrity or their delegate of any missed ultrasonic testing as soon as practicable.

3.7.2. Inspection Frequency

Table 3-10 Continuous Ultrasonic Rail Defect Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Continuous Ultrasonic Rail Defect Identification Inspection	7 MGT	7 MGT	7 MGT

Note: Rolling Stock related defects, such as dragging-wheels and/or flat-wheels, may cause rail defects and give cause to carry out additional ultrasonic rail inspection.

3.7.3. Reference Documents

Document Reference / ID	Title / Description
Procedure 0131834	Non-Destructive Testing of Rail and Rail Welds
AS 2083	Calibration of Equipment
AS 1085.20	Weld Test Procedure
AS 1929	Non-Destructive Testing – Glossary of Terms
AS 3998	Non-Destructive Testing – Qualification and Certification of Testing Personnel
AS 2207-2	Non-Destructive Testing – Ultrasonic Testing of Fusion Welded Joints in Carbon and Low Alloy Steel

Document Reference / ID	Title / Description
ROA W2-89-1-92	Ultrasonic Testing of Rail in Railway Applications

3.7.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

Defects identified that require immediate response (as defined in Section 4.3) shall be reported immediately to the relevant area track maintenance supervisor so that mitigation and rectification works can be initiated. Defect reports documenting all defects identified shall be provided daily and used to raise work notifications in 1SAP and for upload to RAMSYS.

3.8. Ballast Inspection

3.8.1. Inspection Purpose

Ballast inspections shall be carried out to assess the condition of the ballast, sub-ballast and formation below what is visible at the surface. These inspections shall include trial pits as required and may include ground penetrating radar inspections.

Trial pit inspections may be required in the following situations:

- Visible signs of ballast degradation (whitening of the ballast, powdered and rounded ballast) are identified during other inspections.
- Track pumping (excessive vertical movement) is identified during other inspections.
- IOC defects indicative of track support issues.
- Bog holes are identified during other inspections.
- Track geometry defects are identified and not resolved with standard maintenance practices.
- Concerns are raised regarding locations of shallow or deep ballast.
- Ground penetrating radar identifies areas of concern.
- Scoping of track renewal sites.
- Heavy vegetation growth is identified during other inspections; and or
- Narrow formation resulting in fall away of ballast shoulders is identified during other inspections. Trial pits should be excavated beneath the rail seat to a depth sufficient to identify the base of effective ballast. Measurements and photos should be taken prior to refilling the pit.

Ground penetrating radar inspections may be carried out to assist the assessment of:

- Effective ballast depth.
- Ballast fouling rates.
- Ballast quality; and
- Indicative deterioration rates.

Note that ballast profile shall be monitored during visual track inspections and with Track Condition Monitoring Vehicles if practicable.

3.8.2. Inspection Frequency

Table 3-11 Ballast Inspection Frequency

Inspection type	Track Category 1	Track Category 2	Track Category 3
Trial Pit Ballast Inspection	As required	As required	As required
Ground Penetrating Radar (GPR) Inspection	3-5 years or as required	As required	As required

3.8.3. Inspector Qualifications

The person carrying out the trial pit ballast inspection shall:

- Meet the qualification requirements as per section 3.1.4.
- Be competent in identifying ballast fouling; and
- Be knowledgeable regarding this Code of Practice.

The person carrying out the ground penetrating radar inspection shall:

- Be expertly trained and competent in executing ground penetrating radar inspections; and
- Have previous and demonstrated experience in use of ground penetrating radar technology on railways.

3.8.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

Details regarding trial pit location, date of excavation, depth measurements and photos should be stored.

3.9. Turnout Inspection

3.9.1. Inspection Purpose

Turnout inspection frequencies and content shall comply, as a minimum, with that defined in Section 3.9.2 which considers turnouts based on track category. In addition to further inspections may be required based upon the criticality of the turnout as defined in document 0136297.

Turnout inspections, encompassing inspection of the switch and crossing areas, shall be carried out to check the general condition of all aspects of the turnout in question to ensure safe passage of rail traffic. The person executing the inspection should keep a lookout for defects and conditions (i.e. indicators of a defect) that may affect the integrity of the turnout structure.

Turnout inspections shall be carried out on foot and may be completed during visual track inspections. Regular walk-though inspections require only visual checks of the switch and crossing components however detailed inspections shall include measurements of the critical parameters which shall be compared to the thresholds defined in Section 4.6. Minor defects identified during the inspections, such as missing or loose bolts, mal-adjusted spreader bars or unlubricated slide plates, shall be rectified by the person executing the inspection if safe to do so. If not safe to do so, or the person is unable to do so, a notification to carry out the maintenance shall be raised.

Due to the possibility that plastic deformation and flow of rail material may occur in newly installed or recently maintained switch and crossing assemblies, an inspection should be performed one (1) week after installation or maintenance. Turnouts shall be checked for any metal flow and compliance with geometric tolerances. Any metal flow observed shall be ground off to maintain running edge and profile of rail, to correct shape and fit.

When slide chair plates are lubricated 'dry' graphite-based lubrication shall be used. The following shall be checked during inspections of switch and crossing assemblies:

- Condition of running edge and surfaces.
- Line and level through switch and crossing, ensuring the switchblade and swing nose (where applicable) are supported evenly and flat on the slide chair plates, brace plates and chair plates.
- Brace plates in place and secure.
- Condition and correct adjustment of spreader bars.
- General condition, looking for damage throughout.
- Condition of and damage on all insulated connections to the switchblade and crossing; and
- Connecting rods and fittings to switch blades and swing nose (where applicable), ensuring good lubrication of joints to reduce binding.

The conditions that should be noted when observed and either fixed immediately or raised as a maintenance notification include the following listed in Table 3-12 below (noting that exceedance of thresholds in Section 4.6 require immediate response):

Table 3-12 Conditions to be Observed during Turnout Inspection

TURNOUT ASSEMBLIES	
Missing or broken components	Incorrect track geometry
Inadequate track centre to track centre at fouling points	Rail and weld wear and defects
Flange-way not clear throughout turnout	Back gauge incorrect
SWITCH	
Inadequate gauge at the toe of the switch rail and other locations in the critical area	Switch rail toe break
Inadequate switch rail throat opening at the junction of heads or switch tip opening	Switch rail and stock rail wear
Inadequate switch rail toe/stock rail open throw dimension	Switch rail cripple
Switch rail toe/stock rail closed gap	Metal flow on all running rails
Misalignment of switch rails	Poor switch support on chairs and base plates
Heel spread	Poor heel block condition
Ill-fit of switch stops to stock rail	Poor rail chair and baseplate condition / uneven wear patterns
Poor condition of switch rail stops	Poor rail joint condition including bolts
Incorrect gauge at spreader bars	Poor check rail condition

SWITCH	
Obstructions	Poor spreader bracket condition, attachment to switches, and pin or bolt connection to bars
Incorrect clearances of movable components	Poor connecting rod and bar condition and incorrect adjustment
Poor lubrication, condition and visibility; particularly slide plate lubrication and condition of rollers	Inadequate lubrication of all movable pins and bolts
Hand-operated lever operation [AS7642]	Rail flow, surface defects and incorrect wheel-rail interaction on switch blade and stock rail
Damaged switch blades	Incorrect positioning and operation of switch blade rollers
Uneven switch blade support on side plate	Poor spreader bar condition, straightness, insulation; incorrect adjustment / clearance under rails
CROSSING	
Inadequate gauge at critical areas	Running rail wear
Inadequate check rail effectiveness	Poor crossing nose condition
Vertical wear on the crossing nose	Swing nose rails and rail stops [AS7642]
Swing nose crossing bearing on plates [AS7642]	Broken or cracked crossing spacer blocks
Inadequate flangeway clearances	Poor condition of check rail spacers
Inadequate flangeway depth	Poor condition of check rail and crossing bolts
Wing rail wear	Insufficient relief cut in V-rail
Poor rail alignment (including swing nose alignment, longitudinal displacement and swing nose/stock or wing rail gap [AS7642])	
FASTENINGS	
Missing or ineffective fastenings (e.g. corroded, worn, loose) – including clips, coach bolts, screws, insulating spacers, metal spacers)	Incorrect type of fastenings
Damaged fastenings (e.g. from incorrect installation, derailment, vandalism)	

OTHER COMPONENTS	
Insecure, damaged, missing or poor condition base plates and chairs	Loss of or insufficient lubrication
Contamination of slide plate surfaces	Insufficient ballast or poor ballast condition (Ballast – profile and depth beneath bearers, condition particularly beneath and around wheel/rail impact areas, clearance from moving parts)
Poor bearer condition or alignment (including motor mounting bearers)	Signalling components that are insecure, damaged, missing or in poor condition
Insecure, fouled or incorrectly adjusted signalling components – including spreader bars, rods, brackets, pins and bolts	Potential causes of track circuit failure (e.g. metal flow at IRJs, broken IRJ, IRJ deflection ≥7mm, insufficient IRJ gap, etc.)
Poor check rail condition	Missing, ineffective or damaged special components (including gaskets and abrasion plates).
Joints – not dipped (depth ≤2mm / 1 metre)	

3.9.2. Inspection Frequency

Table 3-13 Turnout Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Turnout Walk-through Inspection	7 days	21 days	8 weeks
Detailed Turnout Inspection Note: Increased frequencies may be required based on criticality determined in document 0136297	3 months	3 months	6 months

3.9.3. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4.
- Be competent in identifying turnout and track defects.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.9.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

Appropriate inspections forms shall be completed and submitted to the Track and Signals Analysis and Improvement team within seven (7) days.

3.10. Rail Stress / Creep Testing / Monitoring

3.10.1. Inspection Purpose

Measurement, monitoring and assessment of the longitudinal stress within the rail should be carried out whenever the following events occur, noting that stress adjustment may then be required to return the rail to within the stress-free temperature range:

- New or recycled rail is being laid into track.
- A stress check is being carried out.
- The rail adjustment is suspected to be out of tolerance, for example due to the presence of buckles.
- Break-aways / pull-aparts.
- Significant skewing of sleepers.
- Mechanical joint failure.
- Significant rail creep.
- Significant changes in track alignment.
- Indication of rail movement, such as insulator marks on the rail foot; and
- The rail is cut and welded without consideration of stress management procedures.

In addition, rail stress should be monitored for changes at locations of known stress problems. These may include, but are not limited to:

- Areas of steep gradient.
- Areas with known switch component binding problems; and
- Concentrated areas of broken rails where rail stress was a contributing factor.

Monitoring of rail movement may also be carried out with the use of creep pegs. Though creep pegs will not provide rail stress data, they can be used to provide quantifiable data regarding amounts of movement and relative movement between the two rails.

3.10.2. Inspection Frequency

Table 3-14 Rail Stress & Creep Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Rail Stress Testing	As required	As required	N/A
Rail Creep Monitoring	Continuous at locations with known rail movement problems	N/A	N/A

3.10.3. Reference Documents

Document Reference / ID	Title / Description
WIN - 0108666	Work Instruction - Rail Stress Testing

3.10.4. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4.
- Be competent in the use of the track stress recording or rail creep monitoring equipment.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.10.5. Documentation

Appropriate inspection forms shall be completed and submitted to the Track and Signals Analysis and Improvement team.

3.11. Rail Weld Inspection

3.11.1. Inspection Purpose

Weld inspections shall be carried out to ensure that all welds installed in the track, including aluminothermic, flashbutt and welded repairs, are of suitable quality and finish to reduce the risk of broken welds.

3.11.1.1. Visual Weld Inspection

Immediately after the installation of the weld, and prior to the passage of normal rail traffic, the weld shall be visually inspected to ensure that the surface quality and finish complies with relevant procedures. The weld shall be:

- Clean of any foreign material and excess steel left over from the welding process.
- Suitably ground on the rail head surfaces to provide smooth passage of rolling stock; and
- Left in a condition that allows for non-destructive testing to be carried out.

Following visual inspection, a weld form shall be completed by the welder confirming that no visible defects are present.

3.11.1.2. Magnetic Particle Inspection

All new welds shall be magnetic particle tested within the timeframes set out in the table below.

3.11.1.3. Non-Destructive Internal Rail Defect Inspection

All new welds shall be non-destructively tested for the presence of internal rail defects within 14 days of installation. Testing shall comply with relevant specifications and shall confirm or otherwise the presence of internal defects that may cause the weld to fail.

3.11.2. Inspection Frequency

Table 3-15 Rail Weld Inspection & Testing Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Visual Weld Inspection	Immediate after Production/Installation	Immediate after Production/Installation	Immediate after Production/Installation
Magnetic Particle Testing	Within 14 days of installation	Within 14 days of installation	Within 14 days of installation

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Non-Destructive Testing Inspection All New Welds	Within 14 days of production	Within 14 days of production	As Required

3.11.3. Reference Documents

Document Reference / ID	Title / Description
AS 2083	Calibration of Equipment
AS 1085.20	Weld Test Procedure
WIN-0128935	Magnetic Particle Inspection - Aluminothermic and Flashbutt Welds
Procedure 0131834	Non-Destructive Testing of Rail and Rail Welds
Procedure 0130845	Flashbutt Welding Of Rail
Procedure 0130898	Aluminothermic Welding of Rails

3.11.4. Inspector Qualifications

The person carrying out the visual weld inspection shall:

- Be suitably qualified as per SPEC-000-C-12002.
- Be a trained and competent BHPIO Rail Welder.
- Be assessed as having working knowledge of weld failure mechanisms; and
- Assessed as being competent in using this Code of Practice.

3.11.5. Documentation

Appropriate inspection forms shall be completed and submitted to the Track Condition Monitoring team. Weld reports and non-destructive weld testing reports shall be loaded to the weld management system which should be used to track all welds in track and their testing status.

3.12. Level Crossing Inspection

3.12.1. Inspection Purpose

General level crossing inspections shall be scheduled in accordance with frequencies set out in Section 3.12.2 and should be carried out when suspected defects are identified from conditions observed during other inspections. General Inspections shall be sufficient to observe and document level crossing condition and significant changes in condition since the previous inspection. The integrity of level crossings should be assessed to verify capacity to safely perform the required function. Where changes to the configuration or condition of the level crossing have been identified, an appropriate capacity assessment should be made to determine required actions.

General inspections shall include the tasks of the visual track inspection and in addition look for conditions or changes in the conditions which may affect the function of the level crossing including the following:

- Condition of rail.
- Condition of sleepers and fastenings.

- Fines build up around rails causing moisture retention.
- Track pumping under load.
- Flangeway clearances.
- Track geometry.
- Condition of road surface and alignment.
- Condition and alignment of crossing panels; and
- Line of sight for both road and rail traffic.

For each level crossing inspected the following should also be carried out:

- Re-inspection of previously reported defects that require monitoring as determined from previous inspections.
- Inspection of known defect types common to the particular level crossing form and material; and
- Site testing and measurement where required.

Detailed inspection shall be scheduled in accordance with frequencies set out in Section 3.12.2 and should be carried out in lieu of a general inspection. A detailed inspection shall address all requirements of a general inspection but shall include sufficient removal of the crossing surface to enable a proper assessment to be made of the condition of the track structure beneath.

3.12.2. Inspection Frequency

Table 3-16 Level Crossing (Public Access) Inspection Frequency

Level Crossing Classification	Track Category	General Inspection	Detailed Inspection
Active Level Crossings	All Categories	3 Month	2 Year
Passive Level Crossings – Goldsworthy Line	All Categories	6 Month	Not required
Passive Bypass Level Crossings	All Categories	12 Month	Not required

Table 3-17 Level Crossing (Private Access) Inspection Frequency

Level Crossing Classification	Track Category	General Inspection	Detailed Inspection
Active level crossings	All Categories	6 Month	2 Year
Passive Level Crossings	Category 1	6 Month	2 Year
Passive Level Crossing – MSF only	Category 2	6 Month	2 Year
Passive level crossing	Category 2	24 Month	Not required
Passive level crossing	Category 3	24 Month	Not required

1. Where a level crossing spans over multiple track categories, the higher track Category classification shall apply.

2. To minimise disruption, detailed inspections should be planned to occur at the same time as maintenance of the crossing, or of the track through the crossing requiring panel removal.

3.12.3. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.13. Bridge and Culvert Inspection

3.13.1. Inspection Purpose

The integrity of bridge and culvert structures shall be assessed to verify their capacity to safely perform the required function. Where changes to the configuration or condition of a bridge or culvert are identified, an appropriate capacity assessment should be carried out to determine required actions. Assessment and subsequent actions should be in line with the documents specified in relevant parts of Section 1 of this Code of Practice and be performed by a suitably qualified engineer.

Inspections shall be scheduled in accordance with frequencies set out in Section 3.13.2 and shall also be carried out when suspected defects are observed during other visual inspections.

Detailed inspections shall be carried out in accordance with relevant procedures shown in Section 3.13.3. Detailed inspections shall be sufficient to observe and document structure condition, including condition of the track over the structure, and encompass maintenance activities such as but not limited to:

- Bolt tightening.
- Debris clearing.
- Cleaning; and
- Maintenance of access routes.

Structural inspections shall be carried out in accordance with relevant procedures shown in Section 3.13.3 and in accordance with the frequencies set out in Table 3-18. Structural inspections should also be carried out following flood events in which water levels reached or exceeded the top of headstocks. Bridges and culverts should be checked for scour and other obvious defects that may be caused by flood water following flood events resulting in water levels at or in excess of half (1/2) the pier height or three quarters (3/4) the culvert height.

Structural inspections shall be sufficient to observe and document structure condition and significant changes in condition since the previous inspection. Inspections shall include the tasks of the visual track inspection, focused around the track conditions on and approaching the structure, though this aspect may be carried out separately from the main structure inspection. The conditions or changes in conditions which may affect the function of the bridge include the following:

- Defects or changes in the structural integrity of components, i.e. corrosion, concrete degradation;
- Loose, missing or damaged bolts and components in deck joints.
- Restricted movement or improper functioning deck joints.
- Looseness or major damage such as cracking, splitting, distortion or excessive movement of deck, girders, piers, abutments, braces, abutment sheeting and wing walls.
- Obvious defects such as spalling, cracking, staining, dampness, corrosion or excessive vibration in any component.
- Termite activity, rotting, marine borer or other insect attack on timber transoms.
- Noticeable build-up of deposits of aggressive salts, dirt, silt debris and bird droppings on iron and steel elements.

- Damage caused by derailment, collision, dragging equipment on rolling stock or vandalism.
- Undermining of footings and foundations.
- Erosion and scour of embankments.
- Unusual discolouration.
- Unusual seepage of water.
- Restricted drainage of weep holes in abutments and retaining walls.
- Accumulations of debris, vegetation growth, silting and scour in waterways under the bridge; and
- Crushing of components.

For each structure inspected the following should also be carried out:

- Re-inspection of previously reported defects that require monitoring as determined from previous inspections.
- Inspection of known defect types common to the particular structural form and material; and
- Site testing and measurement where required.

Structural verification, certification and non-destructive testing shall be carried out by independent 3rd parties and shall be scheduled to occur in accordance with the frequencies set out below.

3.13.2. Inspection Frequency

Table 3-18 Bridge and Culvert Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Bridge and Culvert Detailed inspections	1 year	1 year	1 year
Bridge Structural Inspections	1 year	1 year	1 year
Culvert Structural Inspections	5 years	5 years	5 years
Structural Verification	5 years	5 years	5 years

3.13.3. Reference Documents

Document Reference / ID	Title / Description
WIN – 0076702	1Y Mechanical Inspection Bridge Transom
WIN – 0076703	1Y Mechanical Inspection Bridge Ballast
WIN – 0076704	1Y Mechanical Service Bridge Transom
WIN – 0076705	1Y Mechanical Service Bridge Ballast
WIN – 0076706	1Y Mechanical Inspection Bridge Transom WAH
WIN – 0076696	1Y Safety Certify Rail Bridge
WIN – 0076714	1 Year Mechanical Service of a Culvert
WIN – 0076715	5 Year Structural Inspection of a Culvert

Document Reference / ID	Title / Description
WIN – 0106584	Remove / Replace Handrails DeGrey Bridge
WIN – 0076701	Installation MSA Rail Slider WAH
WIN – 0076709	Verify Common Bridge Type A WAH
WIN – 0076710	Verify Common Bridge Type A
WIN – 0076717	Verify Common Bridge Type D WAH
WIN – 0076718	Verify Common Bridge Type D
WIN – 0076720	Culvert Service
WIN – 0106586	Fastening Bolts on Bridge structures
WIN – 0106589	NDT of Infrastructure
WIN – 0106590	Timber Transom Bridge inspections
WIN – 0106592	Ballast Deck Bridge Inspections
WIN – 0112355	Ballast Pan Hungry Board Replacement
Standard – 0018959	Structural Integrity Management Standard
AS 4100	Steel Structures
AS 3600	Concrete Structures
Asset Management Managed Document AM0001317	Corrosion Classification And Treatment
Asset Management Managed Document AM0106047	Structural Integrity Management E-Room Structure
Asset Management Managed Document AM0106052	Structural Integrity Completing Inspection Records Using The Structural Defect Register Spreadsheet
Asset Management Managed Document AM0106053	Structural Integrity Inspection Review Using The Structural Defect Register Spreadsheet
AREMA Ch 1.4 Engineering	American Railway Engineering and Maintenance of way Association – Chapter 1 Part 4 Culverts
AREMA Ch 10	American Railway Engineering and Maintenance of way Association – Chapter 10 Structures, Maintenance and Construction
AREMA Ch 15	American Railway Engineering and Maintenance of way Association – Chapter 15 Steel Structures

3.13.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.14. Railroad Earthworks Inspection

3.14.1. Inspection Purpose

Earthworks inspections at locations such as embankments and cuttings shall be carried out to confirm the presence of suspected defects identified from other visual inspections or in response to reported

movement, instability or failure of earthworks. The condition of the earthworks at the location shall be assessed to verify their capacity to safely perform the necessary function, determined in terms of providing both stability and clearances to track structures.

Sections of track with identified earthworks instability or with a history of earthwork instability should be nominated as special locations until rectification or earthworks stabilisation work can be carried out. A register of these locations shall be maintained and inspections scheduled within 1SAP. Inspections of special locations shall be scheduled at intervals appropriate to each location dependent on nature of instability, condition and other seasonal factors, but should not exceed 6 months. These inspections shall also be considered following significant events as per Section 3.18. These inspections shall have sufficient detail to observe and document earthworks conditions and changes in condition that affect their vulnerability to instability.

Earthworks inspections may include use of monitoring equipment and analysis for the purpose of identifying the cause of any earthwork instability, and correctly specifying the required remedial works. As a minimum standard, the inspection must cover:

- Significant rock fall.
- Blocked drains.
- Track washouts; and
- Perceived hazards to operations or personnel working in the vicinity.

Rail traffic may need to be restricted until the suspected defect or failure is inspected and the necessary actions assessed.

3.14.2. Inspection Frequency

Table 3-19 Earthworks Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Earthworks Inspection	As required		
Special Location[1] Scheduled Earthworks Inspection	Scheduled frequency based upon historic performance and current condition of the special location, but not exceeding 6 months		

Note 1: Special locations are locations of poor historical performance.

3.14.3. Inspector Qualifications

The person carrying out the inspection shall:

- Be a suitably qualified Civil Engineer, experienced in earthworks.
- Be competent in identifying earthwork defects; and
- Have knowledge of local factors.

3.14.4. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.15. Access Road Inspection

3.15.1. Inspection Purpose

The purpose of access road inspections is to check the general condition of all aspects of the access road to ensure safe passage of vehicles. The person executing the inspection should keep a lookout for conditions that may affect the integrity and safe use of the access road.

These inspections should be carried out from a road vehicle traveling at a speed consistent with the scope of the inspection. Minor defects that are identified, such loose items in the access road, shall be rectified by the person executing the inspection if safe to do so. If not safe to do so, or the person is unable to do so, a notification to do the repairs shall be raised.

The person carrying out the inspections shall look out for the following:

- Missing delineators.
- Missing or damaged signs.
- Inadequate sighting distances.
- Obstructions.
- Sections of the access road that are impassable to road traffic.
- Sections of the access road that are restricted to particular vehicle types.
- Washaways – (particularly important following extended periods of wet weather or significant rain events).
- Corrugation of the road surface.
- Missing, damaged or dirty signage; and
- Depth of water a creek crossings. (particularly important following extended periods of wet weather or significant rain events).

3.15.2. Inspection Frequency

Table 3-20 Access Road Inspection Frequency

Inspection Type	Frequency
Access Road Inspection	As required following significant events, but not exceeding 4 weeks

3.15.3. Reference Documents

Document Reference / ID	Title / Description
0138559	Insp Road Conditions – Rail Access Roads
SPEC-000-C-12009	Roadworks – Unsealed Access Roads

3.15.4. Inspector Qualifications

The person carrying out the inspection shall:

- Be suitably qualified to drive on the BHPIO access road.

- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.15.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.16. Railroad Signs Inspection

3.16.1. Inspection Purpose

Inspections of railroad signs shall be undertaken to ensure that all signs are to standard, are visible and conspicuous and are performing the function intended. This inspection shall include the tasks detailed in Section 3.1 relevant to signs in addition to inspection of the line of sight. This inspection shall be carried out by on-rail inspection at the specified sight distance as near as practicable to the train driver's normal operating position.

Inspections may be undertaken as part of other inspections if the speed of inspection is adjusted accordingly to provide adequate time to execute the inspections.

3.16.2. Inspection Frequency

Table 3-21 Signage Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Sign Inspection	1 year	1 year	1 year

3.16.3. Reference Documents

Document Reference / ID	Title / Description
WIN - 0071998	Stat Inspect Signage

3.16.4. Inspector Qualifications

The person carrying out the inspection shall:

- Meet the qualification requirements as per section 3.1.4.
- Be competent in identifying required signage.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.16.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.17. Clearances Inspection

3.17.1. Inspection Purpose

Clearance inspections shall be carried out to ensure the maintenance of a rail corridor with sufficient clearance to allow the safe passage of trains past structures and adjacent tracks and rolling stock. Section 2.15 should be consulted for details regarding required clearances.

Clearance inspections shall include all relevant parts of the track visual inspection and include measurements of the following:

- Clearance from datum points to specified locations.
- Distance between track centrelines (including fouling clearances at turnouts).
- Track cant if specified on the datum; and
- Track curvature if specified on the datum.

These inspections and measurements shall be carried out at special locations of known clearance degradation or potential clearance degradation. A register should be populated and maintained documenting these special locations. Inspection frequencies should consider the associated level of risk, potential degradation rates and seasonal variations at the clearance location. Laser scanning technology may be used to aid in the measurement of clearances.

A clearance inspection including determination of the available clearances should also be carried out when there are suspected defects following work affecting the location of the track(s) or structure or defects are identified during other visual inspections.

Where clearances are not in compliance with requirements referenced in this Code of Practice then consideration shall be given to risk mitigation actions including but not limited to temporary speed restrictions, temporary track closure and temporary structure closure until remediation works are carried out.

3.17.2. Inspection Frequency

Table 3-22 Clearance Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Clearance Inspection	As required	As required	As required
Special Location Scheduled Clearance Inspection	Scheduled frequency based upon historic performance and current condition of the special location, but not exceeding 6 months		

3.17.3. Reference Documents

Document Reference / ID	Title / Description
076-M-01285	Rolling Stock Handbook Index Page
076-M-01287	Load out Tunnel Clearance Diagrams
076-C-12000	Kinematic Envelope and Static Outline (Under Review)
003-M-12003	Car Dumpers – Locomotive and Ore Car Clearance
000-M-00067	Railway Rolling Stock Line Clearance Diagram

Document Reference / ID	Title / Description
DESC-000-C-00001	Design Criteria Track Design
CD - 0168172	RRB MANUAL RTM04 Work Trains

3.17.4. Inspector Qualifications

The person carrying out the inspection shall:

- Be suitably qualified to carry out clearance measurements.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.17.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.18. Significant Event Inspection

3.18.1. Inspection Purpose

Significant event inspections shall be carried out after one of the following events occur with a severity such that verification of the condition of the track or any track supporting structures is required prior to opening the track for normal traffic:

- Major rainstorms, sustained heavy rainfall and or flooding.
- Cyclone.
- Seismic activity.
- Fire.
- Derailment.
- Track obstruction.
- Landslides.
- Structural collapse; and
- Extreme hot weather.

Inspections that may be required, and shall be considered whether applicable to each event type, include but are not limited to:

- Visual Track Inspection.
- Detailed Track Inspection.
- Track Condition Monitoring Vehicle Inspection.
- Switch and Crossing Inspection.
- Bridge and Culvert Inspection.
- Earthworks Inspection.
- Access Road Inspection; and
- Signs Inspection.

Detailed inspections as per the relevant parts of Section 3 may be required to determine the presence and severity of suspected defects identified from other visual inspections or in response to reported defects such as track buckles, track shift or rail pull-apart to allow actions to be determined. Temporary speed restrictions shall be considered until suspected defects can be assessed.

Significant event inspections of track, bridges and culverts are necessary to determine if the structural integrity of any track or track supporting structure has been compromised. If integrity cannot be determined initially by visual inspection, then a trained and competent person, prior to opening the track to normal rail traffic, shall consider whether temporary speed restrictions are required at the affected locations until detailed inspections can be carried out. If any bridges or culverts have been found to have compromised structural integrity, it is important that the response is proportional to the risk and severity of the damage sustained. The Track and Signals Cyclone procedure (0113700) shall be adhered to for all cyclone events.

3.18.2. Inspection Frequency

Table 3-23 Significant Event Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Major Rain Event and / or Cyclone / Flooding			
Visual Track Inspection	As soon as practicable following improvement in weather conditions and a sufficient lowering of water levels to allow an inspection to be executed safely as per CD 0113700		
TCMV Inspection			
Bridge and Culvert Inspection			
Access Road Inspection			
Seismic Activity			
Visual Track Inspection	Following the end of notable seismic activity		
Bridge and Culvert Structural Inspection			
Fire			
Visual Track Inspection	As soon as practical once the fire has passed and a fire authority has deemed that it is safe		
Bridge and Culvert Inspection			
Derailment / Track Obstruction / Structural Collapse / Landslides			
Detailed Track Inspection	As soon as practicable following rectification works post the event		
Bridge and Culvert Inspection			
TCMV Inspection			
Extreme Hot Weather			
Visual Track Inspection	As close as possible to the time of the peak temperature for the day if the peak ambient temperature exceeds 50 degrees Celsius		
Detailed Track Inspection	On the day prior to or following the onset of peak temperatures		

3.18.3. Reference Documents

Document Reference / ID	Title / Description
CD 0121599	WAIO Extreme Weather Procedure
CD 0113700	Track and Signals Cyclone Procedure

3.18.4. Inspector Requirements

The inspector shall comply with the requirements of the particular inspection type as detailed in the applicable part of Section 3.

At all sites where a significant event has occurred the personnel carrying out the inspections shall be aware of the potential hazards involved in inspecting the site. This includes but is not limited to the following hazards:

- Burnt stumps and trees.
- Melted and hot assets.
- Falling objects.
- Stored energy.
- Unstable land and underfoot conditions.
- Flash flooding.
- Flowing water; and
- Fallen power lines.

3.18.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

3.19. Derailers

3.19.1. Inspection Purpose

Derailer inspections shall check and confirm that derailers are functional, safe to operate and fit for purpose. They shall be free of defects and set within correct tolerances.

3.19.2. Inspection Frequency

Table 3-24 Derailer Service & Inspection Frequency

Inspection Type	Track Category 1	Track Category 2	Track Category 3
Derailer Major Service and Inspection	N/A	1 Year	1 Year

3.19.3. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-C-12004	Design, Manufacture and Supply Heavy Haul Railway Derailer Specification

Document Reference / ID	Title / Description
Doc 0147644	Western Cullen Hayes Derailer Procurement Reference Guide
TMAN-000-R-00002	Bi-directional Derailer Assembly Technical Manual
TMAN-000-C-12006	Derailer Assembly, Installation, Operation and Maintenance Technical Manual
TMAN-073-R-00015	Siemens D150 Derailer and C150 Crowder Installation and Mounting Details

3.19.4. Inspector Qualifications

The person carrying out the inspection shall:

- Be suitably qualified to carry out derailer inspections.
- Have knowledge of local factors; and
- Be knowledgeable regarding this Code of Practice.

3.19.5. Documentation

Confirmation of successful inspection completion, along with any further required actions shall be documented in 1SAP.

4. Defects

4.1. Defect Response Codes

The following table details the responses that shall be applied when a defect is detected or observed on track. These codes apply consistently across all defect types. For all defects, the response for the most severe measurement shall apply.

Table 4-1 Defect Response Codes

Response Code	Track Category 1	Track Category 2	Track Category 3
A	Close track until fully repaired OR Protect AND then treat as Response Code B	Close track until fully repaired OR Protect AND then treat as Response Code B	Close track until fully repaired OR Protect AND then treat as Response Code B
B	Apply 25kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) daily until repaired	Apply 10kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) daily until repaired	Apply 10kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) daily until repaired
C	Apply 45kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) during scheduled inspections until repaired	Apply 25kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) during scheduled inspections until repaired	Apply 25kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) during scheduled inspections until repaired
D	Apply 60kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) during scheduled inspections until repaired	Apply 45kph TSR Protect if required Carry out inspection of the defect and protection (if applicable) during scheduled inspections until repaired	Protect if required Monitor for deterioration of defect during scheduled inspections until repaired
E	Protect if required Monitor for deterioration of defect during scheduled inspections until repaired	Protect if required Monitor for deterioration of defect during scheduled inspections until repaired	Protect if required Monitor for deterioration of defect during scheduled inspections until repaired

Where the assessment responses include increased monitoring, knowledge of local performance history and local factors that may affect deterioration rate of the defect concerned is required. The increased

monitoring frequency should be determined by these factors. Increased monitoring should be continued until rectification work is carried out or until the defect is re-assessed and the response is downgraded.

Defects are subject to re-assessment at any time. This reassessment may result in a response action that is more stringent or less stringent. Lifting or relaxing of Temporary Speed Restrictions (TSRs) shall only be carried out by personnel with a current TSR lifting competency.

Temporary Speed Restrictions should only be imposed in conjunction with completion of a Temporary Speed Restriction form. If a TSR is placed by non-track maintenance staff, such as train drivers, the area shall be inspected and a TSR form (including the reference number) completed within 24 hours by a competent person from the Track and Signals department.

Each TSR shall be given a unique reference number. The reference number is located at the top of the TSR form and shall be written in the format below:

Initials/Day/Month - Number (for that day)

(E.g. John Smith imposes his first TSR on 12th July, the reference will be JS1207 – 01)

It is mandatory that this reference number is given to train control when any TSR is placed by track maintenance personnel.

4.1.1. Critical Areas

Consideration should be given to prioritisation of works at bridges, turnouts and level crossings.

4.1.2. Repair Timeframes

For some defect types a mandatory repair timeframe is provided. These timeframes are provided to reduce the risk of failure due to the defect and to minimise the likelihood of further damage to other track components.

These timeframes are provided in the response tables, shown in brackets after the immediate defect response code. These timeframes must be followed. For example:

(24h) Rectification works must be carried out within 24 hours.

(4w) Rectification works must be carried out within 4 weeks.

(6m) Rectification works must be carried out within 6 months.

If repair timeframes cannot be achieved direction should be sought from Rail Engineering Manager or their delegate via Management of CoP non-compliance – Section 1.2.9 .

4.1.3. Defect Protection

Various forms of protection are available for different defect types to mitigate against catastrophic failure. Protection may take the form of gathering further detailed on-site information to allow for an informed decision to be made in terms of required speed restriction or track closure. It may also involve undertaking a site specific risk assessment in some instances and/or take the form of physical protection. Protection options include but are not limited to the following:

- Install insulated rail joint plates and clamps.
- Install rail fishplates and approved clamps (as per Section 2.8.1.2).
- Reduce train speed for loaded trains, empty trains or both.
- Carry out field observations of trains passing over the defect at defined speeds.
- Clamp switch and crossing in either straight or reverse position.
- Install full-size rail plugs (per Section 2.2.1.6), preferably welded in place immediately, otherwise fish plated and clamped (per Section 2.8.1.2) at each end, with application of 25km/h TSR. This is preferable to the use of rail mini-plugs.

- Install rail mini-plugs using mechanical joints.
  Note that only mini-plugs that have been inspected, ultrasonically tested and verified as fit for use shall be installed in track.
- Mini-plugs shall be uniquely identified and tracked in a register, and ultrasonic testing shall be carried out as per Section 3.7 on a frequency not greater than 3 months (noting that repeat testings will not be required if a rail mini-plug has not been used in track since the last ultrasonic test); and
- Install gauge holding bars in locations prone to gauge spread.

Where mini-plugs are used for defect protection:

- Then shall have a 25 km/h TSR applied. If the defect is in a high-risk area (such as bridges, cuttings, turnouts, or where existing track defects exist), the application of a 10 km/h TSR should be considered.
- They shall be installed as per the work instruction Clamp Rail Defect and Install Mini-Plug (WIN-RTS-RTM-076).
- They shall be prioritised for removal within 24hrs and where not removed they shall be inspected every 24 hours and verified fit for rail traffic, with inspections recorded in 1SAP; and
- Track shall be closed if a mini-plug is not inspected within the required 24 hours. Track shall only be re-opened once the mini-plug has been inspected and deemed safe for loaded traffic.

A suitably trained and competent person shall decide upon the appropriate protection to apply to ensure the safe operation of the railroad is maintained.

If rail fishplates are used as protection for a rail defect at a weld, then bow plates shall be used.

4.1.4. Rail Defect Identification

Defects that have defined specific severity levels should be identified using the following colour coding. The type of defect shall be clear and unambiguous. All other maintenance markings on track, not applicable to defect severity, should be marked in white or pink and shall not be applied using the colours in the table below:

Table 4-2 Defect Severity Colour Coding

Defect	Severity 1	Severity 2	Severity 3
Identification Colour	Red	Yellow	Blue

4.2. Track Geometry and Stability

4.2.1. Geometry

Table 4-3 Geometry Parameter Descriptions

Parameter	Description
Gauge	Gauge is measured between the gauge (or inside) face of the rails 16mm below the surface of the rail.
Line (Horizontal Alignment)	Line is measured using the mid-ordinate offset (versine) of a 10m chord. Limits have been set based on the variation from the actual design versine. A fitted versine (obtained by using the average actual measured versine over a defined length of track such as a curve) can be used in lieu of the design versine where the fitted versine still complies with the minimum design standards.
Top (Vertical Alignment)	Top is measured using the offset 1.8m from one end of a 10m chord.
Cross Level Variation	Cross level is the difference in height between opposing rails at a single point along the track. The variation in cross level is measured as the variation from the design cross level.
Twist	Twist is the variation in actual track cross level (i.e. the difference in level of the two rails) over a defined length.

4.2.2. Singular Geometry Defects

Geometry defects are localised defects where a given geometric parameter exceeds set thresholds over a longitudinal distance of greater than 2 metres. If left in track these defects will contribute to increased maintenance requirements and may deteriorate to a size where the risk of derailment is increased. The implementation of speed restrictions may reduce the impact and likelihood of geometry defects propagating and extend reaction timescales.

The responses defined in this section are based on measurements obtained from the Track Condition Monitoring Vehicle and relate to isolated geometric defects. A more stringent response than that mandated by the geometry alone may be necessary if deterioration of the infrastructure both at the defect and on adjoining track is in evidence.

All quoted thresholds are for loaded track conditions and represent minimum values for each severity band. Due consideration must be given when taking unloaded field measurements as these can be expected to be significantly lower than those measured under load.

Unless stated, all quoted values are both positive and negative limits.

When loss of Top is observed above an under-track structure the structure shall be inspected for structural defects.

Table 4-4 Geometry Defects - Top

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Top (Vertical Alignment)	E (Sev 3)	15mm	20mm	20mm
	D (Sev 2)	20mm	25mm	25mm
	A (Sev 1)	36mm	36mm	36mm

Table 4-5 Geometry Defects - Horizontal Alignment

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Line (Horizontal Alignment)*	E (Sev 3)	18mm	24mm	24mm
	D (Sev 2)	24mm	34mm	34mm
	A (Sev 1)	43mm	45mm	45mm

* Note: Following realignment rectification of a track buckle, the entire misaligned section shall be re-railed. A 25 km/h TSR shall be applied until the entire section is re-railed.

Table 4-6 Geometry Defects - Wide Gauge

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Wide Gauge	E (Sev 3)	+22mm	+24mm	+24mm
	D (Sev 2)	+24mm	+26mm	+26mm
	A (Sev 1)	+28mm	+34mm	+34mm

Note:

- Gauge holding bars shall be used as protection for wide gauge locations with limited accessibility for regular maintenance. Inspection of protection is to be conducted in accordance with Table 4-1.
- Should static gauge be measured at or greater than 1458mm (+23mm) on timber sleeper track or within turnouts, action must be taken to rectify to within maintenance limits within 36 hours of identification.
- Where higher than expected deterioration in wide gauge defects is experienced then a detailed track inspection shall be carried out to assess sleeper and fastening effectiveness.

Table 4-7 Geometry Defects - Tight Gauge

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Tight Gauge	E (Sev 3)	-12mm	-12mm	-12mm
	D (Sev 2)	-14mm	-14mm	-14mm
	A (Sev 1)	-16mm	-18mm	-18mm

Measurement of tight gauge includes the effect of any rail head flow present.

Table 4-8 Geometry Defects - Long Twist

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Long Twist (14.47m)	E (Sev 3)	35mm	40mm	40mm
	D (Sev 2)	40mm	46mm	46mm
	A (Sev 1)	52mm	60mm	60mm

Field measurements may consider base lengths rounded to the nearest metre however due consideration must be given to the measurements being in the unloaded condition.

Table 4-9 Geometry Defects - Medium Twist

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Medium Twist (6.25m)	E (Sev 3)	16mm	20mm	20mm
	D (Sev 2)	20mm	23mm	23mm
	A (Sev 1)	26mm	30mm	30mm

Field measurements may consider base lengths rounded to the nearest metre however due consideration must be given to the measurements being in the unloaded condition.

Table 4-10 Geometry Defects - Short Twist

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Short Twist (1.83m)	E (Sev 3)	14mm	16mm	16mm
	D (Sev 2)	16mm	18mm	18mm
	A (Sev 1)	20mm	22mm	22mm

Field measurements may consider base lengths rounded to the nearest metre however due consideration must be given to the measurements being in the unloaded condition.

Table 4-11 Geometry Defects - Cross Level (Tangent Track)

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Cross Level (Tangent Track) (Deviation from design)	E (Sev 3)	30mm	30mm	30mm
	D (Sev 2)	45mm	45mm	45mm
	A (Sev 1)	75mm	75mm	75mm

Table 4-12 Geometry Defects - Cross Level (Curve Track)

Parameter	Response Code (Severity)	Track Category 1	Track Category 2	Track Category 3
Cross Level (Curved Track) (Deviation from design)	D (Sev 3)	30mm	30mm	30mm
	B (Sev 2)	45mm	45mm	45mm
	A (Sev 1)	75mm	75mm	75mm

4.2.3. Cyclic Geometry Defects

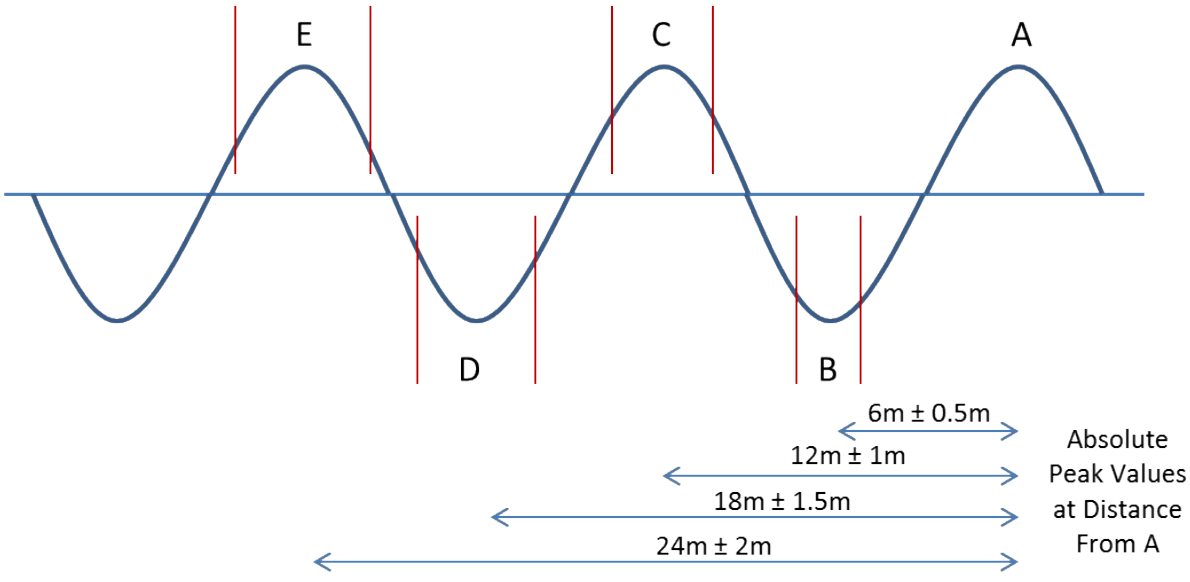
Cyclic geometry defects are known to present an increased risk of derailments when they result in increased dynamic response of rail traffic, in particular ore cars, at a wavelength of approximately 12m.

Cyclic geometry defects shall be categorised when any of the following criteria are found to exist for 2+cycles on an 11-13 metre wavelength:

- ≥ 8 mm Alignment.
- ≥ 10 mm Medium Twist.
- ≥ 5 mm Short Twist; or
- ≥ 6 mm Top.

To identify areas of potential cyclic geometry the following calculation shall be applied to the geometry parameters recorded by the Track Condition Monitoring Vehicle.

Figure 4-1 Cyclic Geometry Calculation Method



Calculation shall be made by summing the absolute peak values at each of the following locations and comparing to the limits set out below for each parameter:

A + B + C + D + E

> 40mm for alignment

> 50mm for medium twist

> 25mm for short twist

> 30mm for top

Identification of potential cyclic geometry from track condition monitoring vehicle data or field measurements shall initiate a detailed track inspection to occur within 24 hours. Upon confirmation of a cyclic geometry problem by a suitably skilled and competent person then a 50km/h temporary speed restriction shall be placed.

4.2.4. Track Geometry Standard Deviations

Track Geometry Standard Deviations (SDs) are units of measurement to assess the smoothness of the track geometry. These values are calculated using the average filtered measured data of the East and West rail from the Track Condition Monitoring Vehicle over a calculation length of 100m.

The Track Condition Index (TCI) is calculated as the sum of the Top and Line Standard Deviations.

The Standard Deviation and TCI values show below are based on report PREP-073-R-00043 – Track Geometry Standard Deviations and TCI.

Track Geometry Standard Deviation values are categorised into four quality bands (T1, T2, T3 & T4) as shown in Table 4-13 from 4-18.

Table 4-13 Plain Line Track – Line Standard Deviation Quality Bands

Quality Band	Track Category 1	Track Category 2	Track Category 3
T1	< 0.90	< 0.90	N/A
T2	≥ 1.20	≥ 1.20	N/A
T3	≥ 1.50	≥ 1.50	N/A
T4	≥ 1.50	≥ 1.50	N/A

Table 4-14 Plain Line Track – Top Standard Deviation Quality Bands

Quality Band	Track Category 1	Track Category 2	Track Category 3
T1	< 1.25	< 1.25	N/A
T2	≥ 1.25	≥ 1.25	N/A
T3	≥ 1.60	≥ 1.60	N/A
T4	≥ 2.00	≥ 2.00	N/A

Table 4-15 Plain Line Track – Track Condition Index (TCI) Bands

Quality Band	Track Category 1	Track Category 2	Track Category 3
T1	< 1.90	< 1.90	< 1.90
T2	≥ 1.90	≥ 1.90	≥ 1.90
T3	≥ 2.20	≥ 2.20	≥ 2.20
T4	≥ 2.75	≥ 2.75	≥ 2.75

Table 4-16 Turnouts – Line Standard Deviation Quality Bands

Quality Band	All Track Categories
T1	<1.25
T2	≥1.25
T3	≥1.65
T4	≥2.35

Note:

- The above values are applicable for the through-track (straight leg) only – not the diverge leg.

Table 4-17 Turnouts – Top Standard Deviation Quality Bands

Quality Band	All Track Categories
T1	<1.45
T2	≥1.45
T3	≥1.85
T4	≥2.5

Note:

- The above values are applicable for the through-track (straight leg) only – not the diverge leg.

Table 4-18 Turnout – Track Condition Index (TCI) Bands

Quality Band	All Track Categories
T1	<2.50
T2	≥2.50
T3	≥3.20
T4	≥4.20

4.2.5. Track Deflection / Pumping

Pumping is the condition that allows excessive vertical movement of the sleeper (estimated to be greater than 7 mm) under load from passing rolling stock, and is generally characterised by the presence of powdering, mud or slurry in the ballast. These conditions may not always be visually obvious and the initial identification of track pumping locations may come from other inspections discussed below. Track geometry criteria may govern in this situation.

Due to track pumping being a movement of the track under load from passing rolling stock, the track condition monitoring vehicle may not observe the full movement due to having lighter axle loads. Track deflection may however be more accurately observed from instrumented ore cars in a loaded condition and track deflection gauges such as void meters. As such, defects should be considered against track geometry and instrumented ore car data as well as the thresholds shown below.

4.2.5.1. Maximum Track Deflection

For singular pumping sleepers, or clusters of consecutive pumping sleepers, Table 4-19 defines the maximum track deflection observed and the applicable defect responses.

Table 4-19 Maximum Track Deflection

Deflection	Track Category 1	Track Category 2	Track Category 3
Deflection > 7mm	E	N/A	N/A
Deflection > 12mm	D (2w)	E (2w)	N/A
Deflection > 20mm	C (2w)	D (2w)	E
Deflection > 30mm	B (7d)	C (7d)	C

4.2.5.2. Clusters of Consecutive Pumping Sleepers

Where clusters of consecutive pumping sleepers are observed, Table 4-20 defines the applicable defect responses. These should be considered in conjunction with Table 4-19 and the most conservative response applied.

Table 4-20 considers that maximum deflection of at least one sleeper exceeds the minimum deflection specified in Table 4-19.

Table 4-20 Clusters of Consecutive Pumping Sleepers

Number Of Consecutive Pumping Sleepers	Track Category 1	Track Category 2	Track Category 3
3 - 5	D	E	N/A
6 - 10	C	D	E
>10	B	C	C

4.2.6. Instrumented Ore Cars

Where an instrumented ore car identifies a track defect then the location shall be inspected and the cause ascertained to enable a notification to be raised in 1SAP for rectification.

Table 4-21 Instrumented Ore Car Defects

Parameter	Defect	Severity	Track Category 1	Track Category 2	Track Category 3
Bounce (mm)	≥ 8mm	3	E	N/A	N/A
	≥ 10mm	2	E	E	N/A
	≥ 15mm	1	D	E	E
Body Rock (mm)	≥ 12mm	3	E	N/A	N/A
	≥ 15mm	2	E	E	N/A
	≥ 18mm	1	D	E	E

Parameter	Defect	Severity	Track Category 1	Track Category 2	Track Category 3
Side Frame Acceleration (g)	≥ 25g	3	E	N/A	N/A
	≥ 40g	2	E	E	N/A
	≥ 50g	1	E	E	E
Suspension Travel (mm)	≥ 12mm	3	E	N/A	N/A
	≥ 15mm	2	E	E	N/A
	≥ 18mm	1	D	E	E

4.3. Rail

4.3.1. Wear

There are generally two types of rail wear. Top wear resulting from the rail head being worn down by rail traffic or grinding, and side wear resulting from the gauge face of the rail being worn by passing wheels.

Top wear is the dominant wear mechanism for low rails of curves, tangent tracks and curves with radius greater than 900 m.

Side wear becomes a significant wear mechanism for the high rail of curves sharper than 900 m radius.

Top wear, side wear or a combination of both will result in a reduction in the rail head cross sectional area. When assessing limits for rail wear, the worst case of top wear, side wear and head area loss shall be used when determining appropriate responses.

Rail wear limits specified in Table 4-22, Table 4-23 and Table 4-24 apply to the worst location and not the average rail wear for the segment of track being considered (such as a curve).

Rail wear thresholds are specified to reduce the risk of broken rails, which may occur more frequently in worn rails. Consideration should be given to the historic prevalence of rail defects when defining rerail priorities.

For rail conditions which approach the applicable wear limit, other factors that may indicate the need for a more stringent response shall be considered; these include but are not limited to:

- Presence, density and history of internal rail defects.
- Presence, density and severity of surface rail defects.
- Ability for ultrasonic testing to be successfully carried out.
- Track support conditions.
- Sleeper and fastening conditions.
- Track geometry; and
- Presence and density of other weak points such as welds.

4.3.1.1. Area Wear Limits

Top wear is measured at the centreline of the rail, perpendicular to the rail foot, and is the difference in rail height between new rail and worn rail. The values shown in the table below refer to 68kg/m rail.

Table 4-22 68kg/m Rail Area Wear Limits

Application	Defect Index Value	Track Category 1	Track Category 2	Track Category 3
All Head Hardened Rail (e.g. OneSteel)	>25	E	E	E
	>40	A	A	A
Curve < 900m (All Through Head Hardened Rail – i.e. Premium Steel)	> 25	E	E	E
	> 40	A	A	A
Curve ≥ 900m Tangent (All Through Head Hardened Rail – i.e. Premium Steel)	> 40	E	E	E
	> 52	A	A	A

Head Hard Hardened rail includes BHP, AIS, One Steel and any Nippon rolled prior to 1992. Through Head Hardened Rail includes HE400, UHC400, SP3 and HEX and any Nippon Rail produced from 1992 or later.

Table 4-23 Rail Area Loss Table

Rail Height (mm)	Top Wear (mm)	Head Area Loss (%) Rail Side Wear (mm)																		
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
185	**1**	4	4	5	6	6	7	8	9	11	12	13	14	15	17	18	19	21	22	23
184	**2**	6	6	7	8	8	9	10	11	13	14	15	16	17	19	20	21	22	24	25
183	**3**	8	8	9	10	10	11	12	13	15	16	17	18	19	21	22	23	24	26	27
182	**4**	10	10	11	12	13	13	14	16	17	18	19	20	21	23	24	25	26	27	29
181	**5**	12	13	13	14	15	16	17	18	19	20	21	22	23	25	26	27	28	29	31
180	**6**	14	15	16	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	33
179	**7**	17	17	18	19	19	20	21	22	23	24	25	26	28	29	30	31	32	33	34
178	**8**	19	20	20	21	22	22	23	24	25	26	27	29	30	31	32	33	34	35	36
177	**9**	21	22	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
176	**10**	24	24	25	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
175	**11**	26	27	27	28	29	29	30	31	32	33	34	35	36	37	38	39	40	41	42
174	**12**	28	29	30	30	31	32	33	33	34	35	36	37	38	39	40	41	42	43	44
173	**13**	31	31	32	33	33	34	35	36	37	38	38	39	40	41	42	43	44	45	46
172	**14**	33	34	34	35	36	36	37	38	39	40	41	42	42	43	44	45	46	47	48
171	**15**	36	36	37	37	38	39	40	40	41	42	43	44	45	45	46	47	48	49	50
170	**16**	38	38	39	40	40	41	42	43	43	44	45	46	47	48	48	49	50	51	52
169	**17**	40	41	41	42	43	43	44	45	46	46	47	48	49	50	51	51	52	53	54
168	**18**	43	43	44	44	45	46	46	47	48	49	49	50	51	52	53	53	54	55	56
167	**19**	45	46	46	47	47	48	49	49	50	51	52	52	53	54	55	55	56	57	58
166	**20**	48	48	49	49	50	50	51	52	52	53	54	54	55	56	57	57	58	59	60
		Within rail wear limits for mainline and yards																		
		Within rail wear limits for yards. Not applicable to mainline track.																		
		Exceedance of rail wear limit for all rail types used in curves of R < 900m AND head hardened rails including BHP, AIS, One Steel and any Nippon rolled prior to 1992 used in curves of R ≥ 900m on mainline track and within yards.																		
		Exceedance of rail wear limit for all rail types used in curves of R ≥900m on mainline track and yards.																		
		NOT applicable to mainline track. Exceedance of rail wear limit for all rail types used in curves of R < 900m AND head hardened rails including BHP, AIS, One Steel and any Nippon rolled prior to 1992 used in curves of R ≥ 900m within yards																		
		NOT applicable to mainline track. Exceedance of rail wear limit for all rail types used in curves of R ≥900m within yards.																		

Note:

- The above head area loss index values are based on PREP-073-R-00036 Rail Wear Report - Lookup Table
- See notes below on side wear and side wear in excess of 10mm.

4.3.1.2. Side Wear Limits

Side wear is measured 16mm below the running surface. The values shown in the table below refer to 68kg/m rail.

Table 4-24 68kg/m Rail Side Wear Limits

Application	Defect	Track Category 1	Track Category 2	Track Category 3
Mainline	Side Wear > 6mm	E	N/A	N/A
	Side Wear > 10mm	A	E	E
Yards	Side Wear > 18mm	N/A	A	A

Increased side wear on curve high rails is allowable on Category 2 and 3 track with a 10km/h speed restriction and increased inspections in place. This situation assumes that:

- There is no side wear on the low rail of the curve.
- Sleepers and fastenings are all effective in restraining the rail and maintaining track gauge.
- Gauge widening has not been applied to the sleepers and fastenings; and
- Head area loss limits are not exceeded.

If these requirements are not met, then a more stringent response is required.

4.3.2. Gauge Face Angle

Table 4-25 Gauge Face Angle

Application	Defect	Track Category 1	Track Category 2	Track Category 3
All	26 degrees	A	A	B

The gauge face angle of rails shall not exceed 26 degrees from vertical, over a length of rail of more than 2m.

4.3.3. Surface

Rail surface defects cause increased dynamic impact loading on the track structure under the passing load of rolling stock. These defects result in damage to other components in the track structure as well as in the wheels of rolling stock and increase the likelihood of internal rail defects forming and resulting in rail breaks.

4.3.3.1. Rolling Contact Fatigue

Table 4-26 Rolling Contact Fatigue Defects

Rolling Contact Fatigue (RCF)	Track Category 1	Track Category 2	Track Category 3
Crack Length > 30mm	E	E	E

Where necessary hand testing shall be carried out to test the depth of RCF.

Note that the application of temporary speed restrictions on curves may cause an increased rate of deterioration of the RCF. The application of a temporary speed restriction shall be used to manage the increased risk of defect formation and rail failure, however the RCF shall be removed as soon as possible, and temporary speed restriction lifted.

At sites with recurring RCF problems the track cant and rolling stock speed shall be assessed to ensure that the correct track geometry is applied.

4.3.3.2. Rail and Weld Surface Irregularities

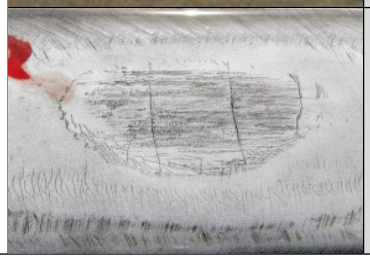
The tolerances for rail running surface irregularities are shown below and cover the following activities:

- Laying of rail in track.
- Production of rail lengths for installation.
- Insertion of rail welds into track including those for closure rails.
- Rail in track; and
- Welds in track.

Where rail is being installed in track, the following parameters shall be checked prior to opening the track for normal traffic. Where rail already exists in track then the following parameters shall be checked to assess the requirements for defect responses including temporary speed restrictions.

Table 4-27 Rail Surface Irregularities

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Peak (Weld) Measured with 1m straightedge and Starret Gauge	> 0.5mm	E	E	N/A
Weld dip	>0mm <0.5mm	E	E	E
Weld dip	≥0.5mm	E (28d) *Clamp & remove	E (28d) *Clamp & remove	E
Weld Alignment (Gauge Face) Measured with 1m straight edge and Starret Gauge	> ±0.5 mm	E	E	N/A
Weld Colour	Blue Weld (ground too hot)	E	E	N/A
AT Weld Position Within Crib	Touching Sleeper	E	E	N/A
Weld Break Out (field side of rail)	Any loss of weld on the field side of a rail	E Clamp within 24 hours	E Clamp within 24 hours	N/A
Corroded Rail	>0mm	E (7d)	E	E
Parameter Head Spalling/Shelling	**Defect**	**Track Category 1**	**Track Category 2**	**Track Category 3**
TYPE 5 Rail Squat ≥50mm in size		E	E	E
TYPE 4 Rail Squat ≥100mm size Rail squat broken out over length of ≥50mm*		E (Plan Removal)	E	E

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
TYPE 3 Rail squat ≥150mm size Rail squat broken out to depth of ≥3mm. Rail squat broken out over length of ≥100mm*		E Remove within 42 days (Protect if required)	E (Plan Removal)	E (Plan Removal)
TYPE 2 Any of Type 3 present in either • AT or FB Weld • Level Crossing • Turnout • Bridge		E Remove within 21 days (Protection Required)	E Remove within 42 days (Protect if required)	E Remove within 42 days (Protect if required)
TYPE 1 All wheel burns		A (Protect with plates & clamps)	A (Protect with plates and clamps)	A (Protect with plates and clamps)
Wheel burns with secondary defects i.e. cracks (Note: Wheel burns are present in both rails)		Close track and remove prior to the passage of the next train	Close track and remove prior to the passage of the next train	Close track and remove prior to the passage of the next train

* For non-continuous breakouts the breakout lengths can be added together

Defects of these sizes will result in increased maintenance requirements and may cause track geometry defects as well as deterioration of components such as sleepers and ballast due to high impact loads.

Increases in the defect response may be required where the rail surface defect causes defects in other assets and parameters. When rail surface defects exist, the competent inspector shall ensure that track deflection and track geometry are checked for defects as a minimum and appropriate responses implemented.

4.3.4. Untestable Rail

Once Rail has been identified as untestable as defined within Procedure 0131834 – Non-Destructive Testing of Rail and Rail Welds, the following immediate actions / controls shall be applied for untestable rail:

- Place a 25 km/h TSR on the specific section of track.

- Ensure the responsible Track Maintenance Supervisor has been informed. The Track Maintenance Supervisor will then proceed to initiate TSR boards & transponders to the specific location if required.
- The Track Maintenance Supervisor shall inform the Track Grinding Supervisor to arrange the specific section of track to be ground by the rail grinding operations team as soon as practicable.
- Specific section of track is ground to a testable condition.
- The Track Integrity Supervisor shall inform the ultrasonic rail inspections team; track has been ground and awaiting testing.
- The track shall be tested by ultrasonic rail inspection; if track is tested and is deemed satisfactory the TSR can be removed; and
- Ultrasonic rail inspections team inform the track maintenance supervisor to remove all boards and transponders.

4.3.5. Internal

Internal rail defects detected during continuous ultrasonic rail inspections and non-continuous non-destructive rail testing inspections shall be assessed and reported in accordance with the classification, position and sizing codes as specified in 0131834 Non-Destructive Testing of Rail and Rail Welds.

The immediate defect responses along with required timeframes for applying protection are shown in the tables below.

Table 4-28 Internal Rail Defect Protection and Response

Severity	Protection Applied Within	Track Category 1	Track Category 2	Track Category 3
1	Prior to next train	A (24h)(1)	A	A
2(2)	24h	E (21d)(3)	E(4)	E
3(5)	4d	E (42d)(6)	E	E

Notes

1) These defects shall have a 25 km/h TSR applied until defect is removed.

2) All severity 2 defects shall be tested after 14 days have elapsed, and every 4 days thereafter. If defect cannot be tested, track shall be closed until defect is removed or tested.

3) These defects shall:

   - have a 45 km/h TSR applied at day 21 if not removed.
   - have a 25 km/h TSR applied at day 35 if not removed; and
   - close track at day 42 if defect is not removed.

4) These defects shall have track closed at day 42 if not removed.

5) All severity 3 defects shall be tested after 42 days have elapsed, and every 4 days thereafter.

6) These defects shall have a 45 km/h TSR applied at day 42 if not removed.

Note that for the following defect types reported as Severity 1 the rail containing the defect shall be removed from track prior to the passage of the next train. A full-size rail plug may be installed as a temporary form of protection for:

- Broken rail.
- Horizontal split head.
- Horizontal split web.
- Vertical split head.
- Vertical split web.
- Piped rail.
- Head web separation in radius.
- Foot web separation.
- Bolt hole cracked/broken; and
- Wheel burn.

Known defects shall be positively identified in track with indelible marking as per Table 4-2 (Defect colour coding) to ensure traceability as well as visibility to rail mounted vehicle operators.

The repair of identified defects shall be in accordance with Section 5.4.

The following table details response codes for areas of track where fishplates and clamps cannot be fitted.

Table 4-29 Response Codes for Internal Defects Where Fishplates and Clamps Cannot be Fitted

Severity	Response
1	Close track until repaired
2	B (7 days)
3	D (14 days)
3 (bolt-hole crack only)	D (42 days) Testing is required after 14 days and every 4 days thereafter, or close track.

Note: If defect is not removed within the required timeframe, it shall escalate in severity and required response.

4.3.6. Profile

The following table defines the rail profile defects and responses when measured using a profile gauge bar and a 3mm wide feeler gauge.

Table 4-30 Rail Profile Defects (Manual Measurement)

Application	Defect	Track Category 1	Track Category 2	Track Category 3
Gauge -60º to -10º Field +3º to +16º (Non-Contact Areas)	> 0.40mm	E	E	E
-10º to +3º (Running Band)	> 0.20mm	E	E	E
-10º to Gauge Corner Reference Point	> 0.35mm	E	E	E

The following table defines the rail profile defects and responses when measured using an electronic device such as a Miniprof.

Table 4-31 Rail Profile Defects (Electronic Measurement)

Application	Defect	Track Category 1	Track Category 2	Track Category 3
Gauge -60º to -10º Field +3º to +16º (Non-Contact Areas)	> 0.20mm	E	E	E
-10º to +3º (Running Band)	> 0.15mm	E	E	E
-10º to Gauge Corner Reference Point	> 0.15mm	E	E	E

4.4. Sleepers and Fastenings

4.4.1. Missing/Non-Load Bearing Sleepers

Table 4-32 below shall be used in the assessment of response criteria for sleepers that are either missing or providing no support to the rail. Such a condition is likely (but not necessarily) to be due to wash-away damage, fire damage or derailment damage. It may also occur due to old and under-maintained sleepers and fastenings.

Table 4-32 Missing/Non-Load Bearing Sleepers

Cluster Of Consecutive Missing/Non-Load Bearing Sleepers	Track Category 1	Track Category 2	Track Category 3
1 missing or non-load bearing sleeper	C	D	E
2 or more missing or non-load bearing sleepers	A	A	A

Note: Table 4-32 shall only be used when adjacent sleepers are still effective. It refers to a solitary missing or non-load bearing sleeper or two or more consecutive missing or non-load bearing sleepers only.

Where multiple non-consecutive sleepers are missing within a group of sleepers, further assessment by a competent person should be performed.

Where adjacent sleepers to the missing or non-load bearing sleeper(s) are ineffective further assessment using Table 4-33 should be performed.

4.4.2. Ineffective Sleepers and Fastenings

An individual sleeper/fastening assembly is judged ineffective if the sleeper/fastener does not provide adequate lateral, longitudinal and vertical support to the rail, caused by one or more of the following conditions:

- Sleeper deterioration affecting rail support (e.g. Aging, rot, corrosion).
- Sleepers split, cracked or otherwise deteriorated at or through fastening components rendering the fastening ineffective.
- Sleepers broken through.
- Losses of sleeper cross-section or other defects as specified in the sleeper design.
- Fastening assembly components not to specification (e.g. Inadequate number of dogspikes or lockspikes, incorrect components).
- Fastening assembly components missing, broken or loose (e.g. Loose or missing shoulder inserts, anchors) resulting in loss of gauge, alignment or rail holding capacity; and
- Excessive back canting of rail (e.g. Resulting from sleeper deterioration or cutting) resulting in lateral rail or sleeper plate movement.

Where sleepers or fastening assemblies are ineffective and contribute to track geometry irregularities the response tables in Section 4.2 shall be considered.

The assessment of effectiveness should consider such things as partial effectiveness of individual sleepers, the contribution of the whole group to vertical and lateral support and local site conditions. Note that any defect identified shall, if possible, be rectified immediately, otherwise appropriate responses codes shall be adhered to.

The following tables give direction in assessing the responses to different situations, however it should be noted that the tables do not give direction for every combination of defective situations. A competent inspector shall assess the required response for each individual situation considering local factors including combination of ineffective and partially effective sleepers / fastenings.

4.4.2.1. Ineffective Fastenings

An ineffective fastening is any deterioration of the fastening assembly that prevents the rail being suitably fastened to the sleeper. In order to be considered a defect, it must be in consecutive lengths. Examples of ineffective fastenings are:

- Missing or broken pads, insulators or clips.
- Severely worn or partially (25%) slipped out rail pad; and
- Pads, insulators or clips that are observed to be unfastened in track.

Refer to Section 7.2 for ineffective fastening examples.

4.4.2.2. Ineffective Sleepers

An ineffective sleeper is one that cannot provide support to the rails, maintain gauge, or distribute the weight of the rails on the ballast. Examples of ineffective sleepers are:

- Broken or cracked vertically or horizontally with a width > 2 mm, where they compromise rail support by showing signs of movement under load. Hairline cracks are not deemed as structural and are not a defect for this purpose.

- Any number of exposed pre-stressing tendons on the sleeper top or longitudinal direction.
- For timber: rotten, hollow, split partially or completely beyond baseplate footprint, decayed, or showing visible signs of deep plate working.
- Skewed, missing or deformed cast in housing where a clip cannot be inserted. Sleeper housings are considered as a fastening for the purpose of Table 4-34,
- Skewed sleepers misaligned to the point where they are less than or equal to 100 mm apart from the adjacent unit at either end shall be deemed as ineffective: and
- Skewed sleepers or bearers where the skew amount is greater than 120mm and there is a weld within 2 cribs either side of the skewed sleeper then a P2 notification is to be raised to re-align and hand tamp the sleepers or bearers of concern. Figure 7-7

Response codes for ineffective sleepers are given in Table 4-34.

Skewed sleepers are deemed effective if they hold gauge within COP acceptable limits, fully support the rail with all three fastening assemblies on both rails and do not cause another type of geometry defect.

A sleeper or cluster of sleepers with derailment damage of cosmetic nature (e.g. wheel marks) is not considered to be ineffective.

Refer to Section 7.3 for skewed sleeper examples.

Table 4-33 Ineffective Fastenings - Responses

Cluster Of Consecutive Ineffective Fastenings on A Single Rail	Track Category 1	Track Category 2	Track Category 3
Tangents, Curves ≥ 900m Radius			
3 sleepers (6 fastenings)	D	D	E
4 – 5 sleepers (8 - 10 fastenings)	C	D	E
≥ 6 sleepers (≥ 12 fastenings)	A	A	A
Curves < 900m Radius			
3 sleepers (6 fastenings)	C	D	E
≥ 4 sleepers (≥ 8 fastenings)	A	A	A

Note: Priority shall be given to clusters of ineffective fastenings on a single side of a rail, according to the overall degradation in rail support and potential rail instability.

Table 4-34 Ineffective Sleepers and Fastenings - Both Rails

Cluster of Consecutive Ineffective Sleepers or Fastenings on Both Rails	Track Category 1	Track Category 2	Track Category 3
Tangents, Curves ≥ 900m Radius			
≤ 2 sleepers (≤ 8 fastenings)	E	E	E
3 sleepers (12 fastenings)	B	C	C
≥ 4 sleepers (≥ 16 fastenings)	A	A	A
Curves < 900m Radius			
1 sleeper (4 fastenings)	E	E	E
2 sleepers (8 fastenings)	B	C	C
≥ 3 sleepers (≥ 12 fastenings)	A	A	A

Note: Table 4-33 and Table 4-34 do not apply to missing sleepers or sleepers failing to provide any vertical support. See Table 4-32 for missing and non-load bearing sleepers.

Where the response required involves closing the track or protecting and opening at a temporary speed restriction, application of effective fastenings shall occur prior to the next train.

Where adjacent or multiple clusters of ineffective sleepers or fastenings exist, an assessment should be undertaken by a competent inspector to determine if a more restrictive response is required.

4.4.3. Incorrect Sleeper Spacing

Sleeper spacing should be maintained to the design applicable to the section of track. Management of sleeper skewing is required to:

- Maintain track gauge.
- Maintain track geometry.
- Maintain effectiveness of fastenings.
- Minimise damage to sleepers incurred during tamping operations.
- Minimise damage to sleepers during other maintenance works; and
- Enable rerail activities.

4.5. Ballast

4.5.1. Depth

Deviations from the parameters set out in Section 2.5.1 regarding the required depths of ballast will result in accelerated degradation of the ballast and greatly increases the likelihood of the track suffering other defects such as track misalignments (buckles/kicks) and those relating to geometry, track pumping, rail, sleepers and fastening defects among others.

Where ballast depths are inadequate then work should be planned to remediate the problem, though defect responses as described in Section 4.1 will not be triggered unless the track begins to suffer other defects as described in this Code of Practice such as geometry, track pumping and component defects.

4.5.2. Height

The top of the ballast shall not be above a point that is 100mm below the top of rail - i.e. there should be at least 100mm of clearance between the top of rail and top of ballast. Rail fastenings and sleepers shall remain exposed to allow for appropriate inspections.

4.5.3. Shoulder Profile

The responses in Table 4-35 apply where ballast shoulder height (H) and width (W) deficiencies occur over lengths of 10m (17 sleepers) or greater. This deals with general ballast profile deterioration likely to impact on track lateral stability over time. The responses assume that crib ballast has not been substantially degraded from the full design profile.

Significant ballast disturbances, including more severe degradation over distances of less than 10m shall be assessed by a competent inspector taking into consideration factors such as track geometry, curvature, temperatures, rail traffic, and track speed.

Table 4-35 Ineffective Ballast Shoulders

Defective Ballast Profile Over Length Of >10m	Track Category 1	Track Category 2	Track Category 3
Tangents, Curves ≥ 900m Radius, Turnouts ≥ 1:20			
225mm ≥ W > 150mm Or 200mm ≥ H > 125mm	E	N/A	N/A
150mm ≥ W > 75mm Or 125mm ≥ H > 65mm	D	E	N/A
W ≤ 75mm Or H ≤ 65mm	B	C	E A (timber)
H ≤ 0mm	A	A	A
Curves < 900m Radius, Turnouts < 1:20			
375mm ≥ W > 250mm Or 200mm ≥ H > 125mm	E	N/A	N/A
250mm ≥ W > 125mm Or 125mm ≥ H > 65mm	D	E	N/A
W ≤ 125mm Or H ≤ 65mm	B	C	E A (timber)
H ≤ 0mm	A	A	A

Note:

- Height of ballast shoulder (H) is measured from the base of sleeper.
- Shoulder width (W) is measured from the extreme end of the sleeper, not the visible end when the track is fully ballasted.

The following assumptions are made when applying the responses above:

- Temperature is within the design range (see Section 2.2.1).
- Steel sleepers have full pods of ballast. If the pods are less than 3/4 full, then there should be an increased response by 2 categories (e.g. an E response goes to a C).
- Track geometry is within limits specified in Section 4.2.1. Alternate responses may be required according to the track geometry condition: and
- Rail size of 68 kg/m and CWR/LWR (>110 metre) rail lengths.

4.5.4. Condition and Fouling

During normal operation and maintenance practices voids in the ballast layer fill with fines and contaminants. Other track defects can also result in rounded, powdered and crushed ballast, generally occurring in localised areas. The track should be maintained with a minimum of 100mm of clean, angular ballast directly beneath the sleeper.

The following visible surface conditions are indicative of defective ballast:

- Rounded ballast.
- White powder coating on the ballast; and
- Small size of individual ballast particles.

If visual inspection identifies the conditions above or if a detailed inspection of the sub-surface ballast condition suggests that more than 30% of the material is smaller than 13.2mm particle size, then a competent person shall assess whether a defect response is required based upon other conditions such as:

- Extents of inadequate ballast.
- Track geometry.
- Track pumping.
- Rail surface defects.
- Site drainage.
- Sleeper defects; and
- Other external factors.

A notification shall be raised to rectify the inadequate ballast conditions. Where contaminated ballast conditions lead to inadequate sleeper support assessment of track pumping and defective geometry shall be undertaken.

4.6. Turnouts

For turnouts designed and constructed in accordance with Section 2.6 the condition assessment and response criteria for switch and crossing areas should be in accordance with Table 4-36 and Table 4-37 respectively.

IRJ position within turnouts shall be in accordance with the drawing 073-R-00041.

Definition of worn and defective switch and crossing conditions and critical areas for geometry are shown in Table 4-37 and the appendices.

In addition, at all times vertical, lateral, longitudinal and rotational restraint and support of the rails should be maintained to ensure acceptable geometry is presented to the rolling stock wheels. The list below shows other parts of this section that define condition assessment and response criteria for components relevant to switch and crossing structures:

4.2 Track.

4.3 Rail.

4.4 Sleepers and Fastenings.

4.5 Ballast; and

4.7 Mechanical Rail Joints.

Wherever components are changed within a turnout, the rail height difference shall not exceed 5mm so that cross level variation throughout the turnout is acceptable. For example, when a frog is replaced and the rail height difference results in a cross-level variation of greater than 5mm, the opposite rail shall be replaced.

Generally, scheduled inspections shall identify rail defects as per Section 3.9 and Table 3-12.

Where the identified defective condition is only a hazard for the facing condition the speed restriction is only required for the facing movement.

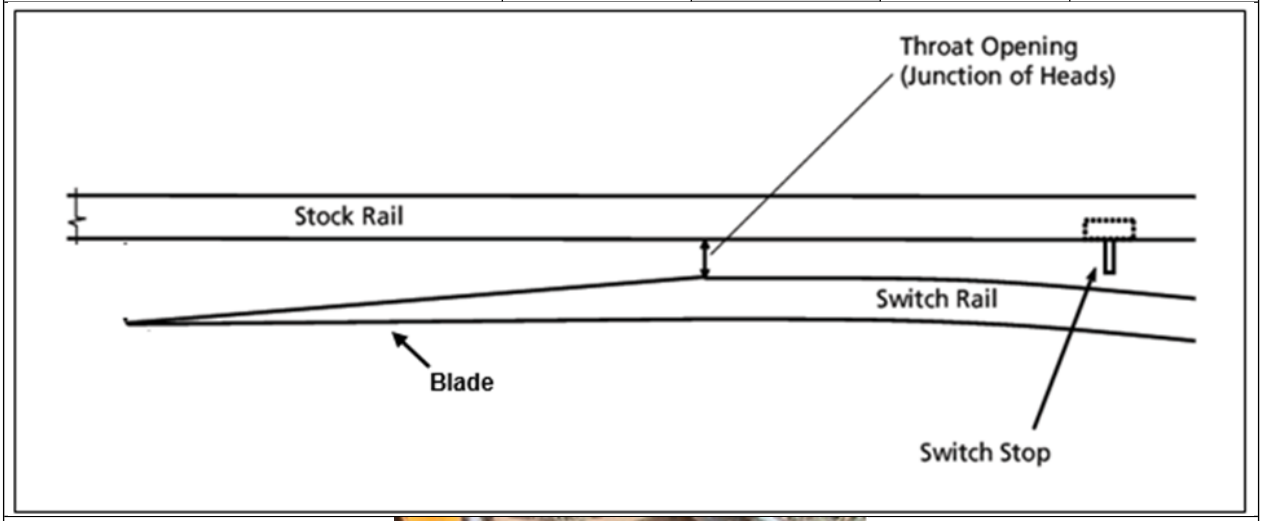
Turnouts where skewed sleepers are observed may use bearer bracing.

If the response code of close track is required but the defective condition only impacts traffic on either the diverge or the straight, but not both, then the switch and crossing may be clamped to prevent use of the defective part of the switch or crossing. A competent inspector shall inspect the assembly to confirm that the turnout can remain open in either the straight or diverge, whilst being protected by use of clamps.

Note: Table 4-37 does not apply to wheel flange bearing crossing designs.

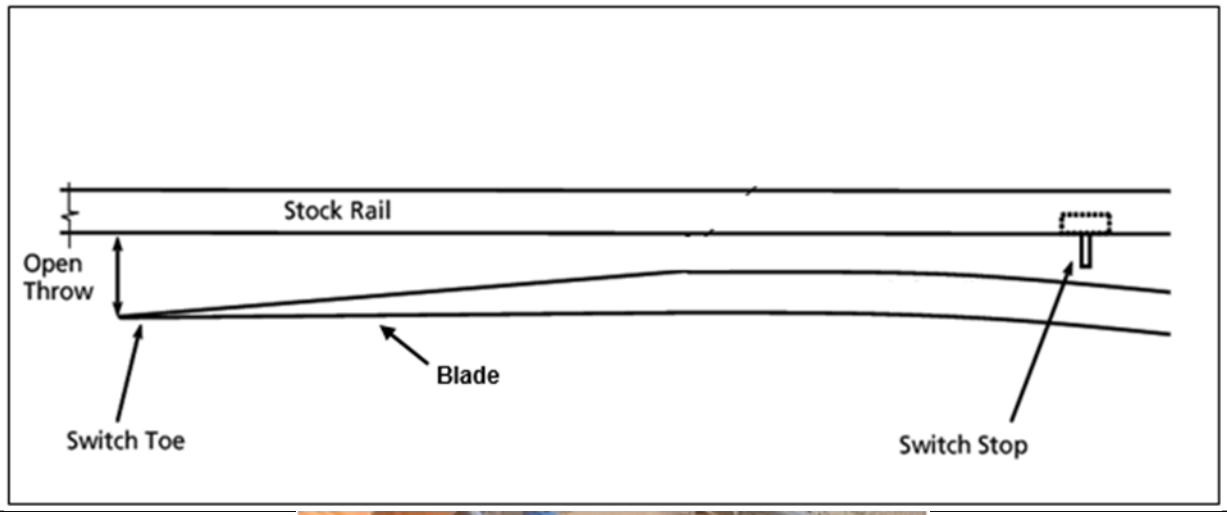
Table 4-36 Turnout Area Defect Responses

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Back Of Switch Rail to Stock Rail Dimension				
Throat Opening dimension. (Junction of Heads) Note: Additional action maybe required for signalling purposes where the switch rail throat opening dimension is less than 50 mm.	< 40mm	C	D	E
	< 35mm	A	A	A



Source: 0126953 Switch Measurements - Maintenance Work Instruction

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Switch Rail Toe to Stock Rail Dimension				
Open Throw dimension Note: Additional action maybe required for signalling purposes.	< 110mm	E	E	E
	< 100mm	B	C	C
An alternative action to those specified is to prohibit facing train movements. At all times the Open Throw dimension shall be greater than at spreader bar locations.	< 90mm	A	A	A



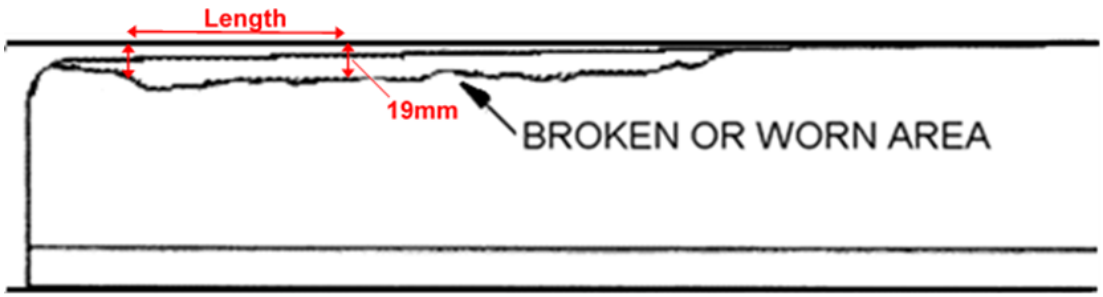
Source: 0126953 Switch Measurements - Maintenance Work Instruction

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Track Gauge (At the Switch Tip)				
Track Gauge dimension Note: For wide gauge in the switch critical area plain track limits also apply.	< 1431mm	D	E	E
	< 1427mm	B	C	C
	< 1425mm	A	A	A

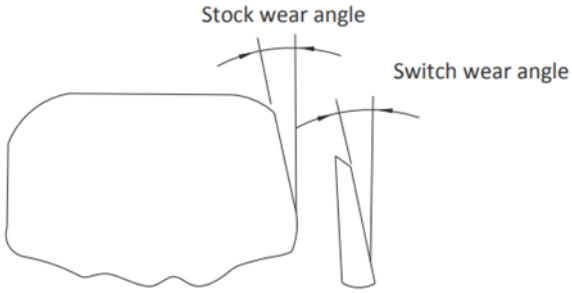
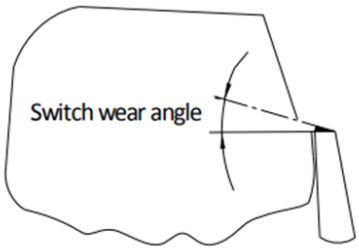
Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Key Component Condition				
Heel block Note: Applies to fixed heel blocks only. Pivot heel cracks and breaks should be assessed by a competent worker.	Broken but still effective	C	D	E
	Missing / Broken & Ineffective	A	A	A
Broken / Ineffective rail-brace / chair	2 consecutive	D	N/A	N/A
	> 2 consecutive	A	A	A
Missing/Ineffective Switch bearing stops (To avoid rail roll-over)	2 consecutive	D	E	E
	> 2 consecutive	A	A	A
Ineffective bearers/ fasteners (in critical area) Note: Refer to Section 4.4 for the definition of “ineffective” sleepers and bearers	2 consecutive	C	C	E
	> 2 consecutive	A	A	A
Spreader Bar (A bent spreader bar is defined as a spreader bar that has any visual signs of a bend) Note: An alternative action that may be taken is to install a switch clip in accordance with safe working rules.	Missing or broken	A	A	A
	Bent critical*	A	A	A
	Bent non-critical**	E (21d)	E (21d)	E (21d)

* Bent critical is where any one of the following conditions exist: - More than 1 spreader bar is bent - Drive rodding is impacted - Point of switch movement is impacted - Track geometry is non-compliant with COP limits - Any other switch parameters are non-compliant with COP limits	
** Bent non-critical is where all the following conditions are met: - Drive rodding not impacted - Point of switch movement not impacted - Track geometry is compliant with COP - Track geometry is not impacted by the bent spreader bar - All other switch parameters are compliant with COP limits	
Ineffective bolts	The competent worker should assess individual defects identified for the effectiveness of the bolts. Ineffective bolts include missing or broken bolts. Loose bolts should be tightened. Missing or ineffective bolts should be replaced. Pivot heel blocks generally may be made up of connections which require some bolts to be not fully tightened providing for design switch movement.
Switch Blade Stiffener Plates - Cracking	Check blade for cracks. If cracks are confined to stiffener plate only, then consider the condition of blade and stock. If in good condition then response code E (monitor) otherwise; If blade/stock are in poor condition then response Code D.
Anti-creep Blocks	If the ball and claw anti-creep devices on the back of heel-less switch blades are in full contact at the front or the back, this requires a response code E. (*Note: rail stress should be adjusted such that the anti-creep blocks are centrally positioned at design SFT – Check & comply with Procedure 0130701 Rail Stress Mgmt.*)

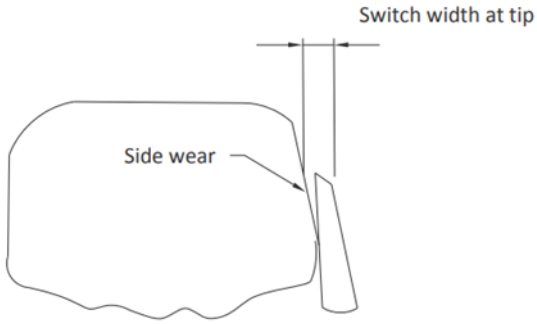
Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Switch Rail / Stock Rail Set *Notes: An alternative action to those specified is to prohibit facing train movements on the relevant rail of the turnout. Applies to conventional switches only (i.e. NOT undercut switches).* *When a worn switch at the end of its service life is being replaced a new switch and stock rail set shall be installed.*				
Switch blade damage (Length of defect with depth > 19 mm from the running surface, anywhere in the switch blade) *Note: "Length of damage" also applies to consecutive areas of damage less than the length specified apart and forming a length greater than the length specified.*	≥ 100mm	E	E	E
	≥ 200mm	A	A	A



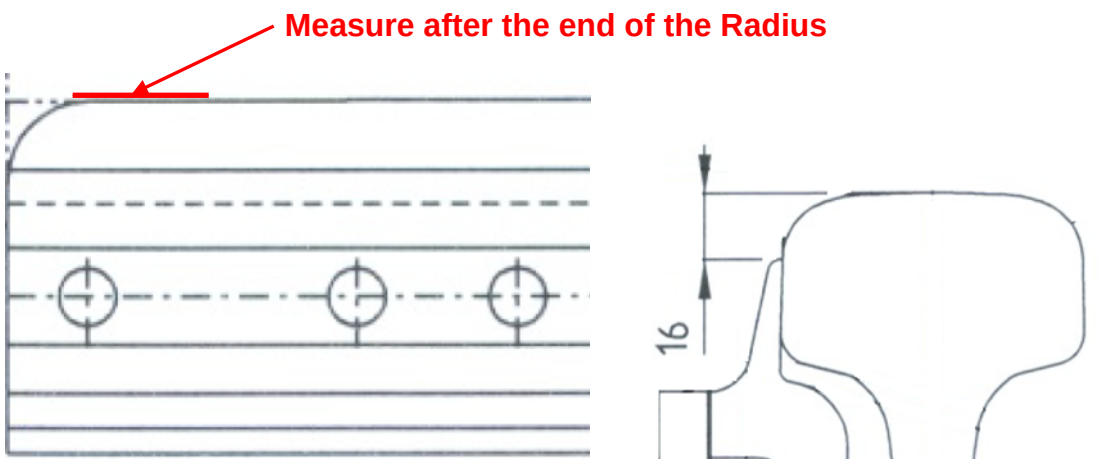
Switch blade longitudinal wear is the length of the switch blade that is worn >19mm below the running surface of the stock rail, measured from the start to end of the defect. The end points can be found by placing a track gauge upside down across both rails and finding the points along the stock where a 19mm gap exists between the gauge and the top of the switch blade.

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Stock or switch rail gauge face angle (from vertical at the point of wheel flange/rail contact at the switch tip area) *Note: Where the gauge face angle limit is exceeded the action should be to replace the switch and stock rail set.*	≥ 18deg.	E	E	E
	≥ 26deg.	A	A	A
 Source: AS7642 – Turnouts and Other Special Trackwork				
Switch rail angle (*from horizontal at any point between 19 mm and 30 mm below the running surface of the stock rail)*	<40deg.	A	A	A
 Source: AS7642 – Turnouts and Other Special Trackwork				

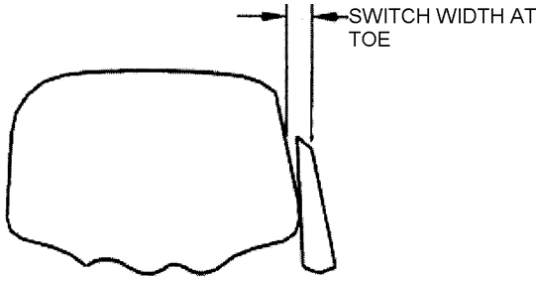
<table>
<tr><th>Parameter</th><th>Defect</th><th>Track Category 1</th><th>Track Category 2</th><th>Track Category 3</th></tr>
<tr><td rowspan="2">Stock rail gauge face wear

(Where the switch rail contacts the stock rail at gauge point)</td><td>≥3mm</td><td>E</td><td>E</td><td>E</td></tr>
<tr><td colspan="4">It is recommended that the stock rail be replaced. Following repair it is necessary to check the fit between the switch rail and stock rail. The replacement of switches should be carried out with care where the stock rail is approaching this amount of wear to ensure a blunt nose is not presented to the wheel.</td></tr>
<tr><td colspan="5"> 

Source: AS7642 – Turnouts and Other Special Trackwork</td></tr>
</table>

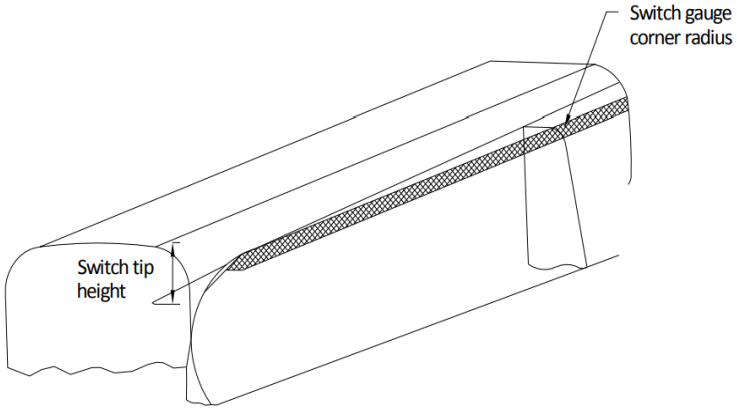
Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Switch tip height *(Distance from stock rail running surface to top of switch rail measured at the top of the arc at the switch nose)* .	13mm	E	E	E
	≤ 12mm	A	A	A
Switch blade vertical wear is measured at the switch toe and is recorded as distance from the crown to the top of the blade toe, at 0mm wear the switch should site 16mm below the crown. The height of the stock rail must also be taken into account. A = Stock Rail Vertical Wear B = Distance from top of rail to top of switch toe Switch Blade Wear = A + B - 16 Measurement B can be taken by placing a track gauge upside down/inverted on the stock rails and measuring the distance between the gauge and the top of the blade.				
				

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Switch tip width (As presented to the wheel) *Note: Switch width includes effects of side wear on stock rails and closed gap between switch and stock rails.* *It is not recommended that the gap between the switch rail and stock rail exceeds 3 mm at any time as this can cause loss of detection.*	≥ 4mm	E	E	E
	≥ 6mm	B	C	C
	≥ 9mm	A	A	A



Switch tip width is recorded as it is presented to the wheel, this is measured as the distance from the gauge side of the switch tip at the toe to the gauge face of the rail.

Switch gauge corner radius	< 6mm	*Note: It is recommended the switch corner radius be maintained to 6 mm or greater particularly where manganese or heat treated materials are used. All new switch and switch sets should be manufactured to meet this recommendation.*



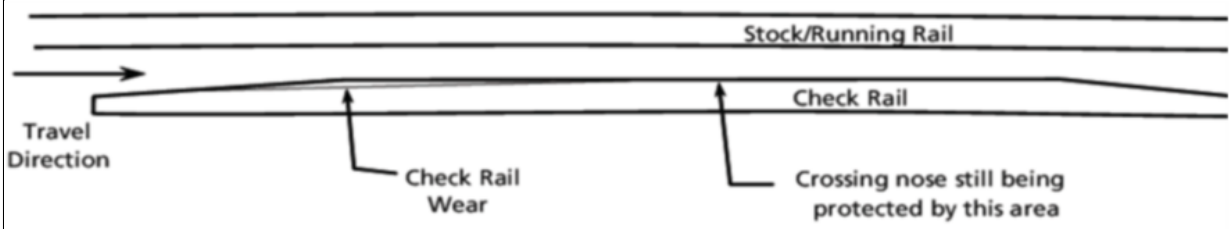
Source: AS7642 – Turnouts and Other Special Trackwork

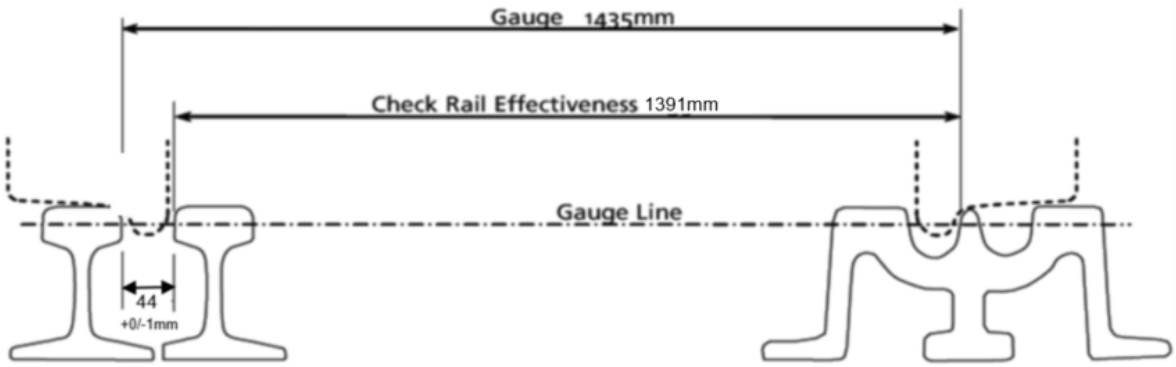
Crippled		*Note: A crippled switch blade refers to a switch blade that has suffered damage from a run through or derailment. Such switch blades may be suitable for temporary repair and re-installation to geometry suitable for train movements at a reduced speed. The switch blade may have been bent, twisted or have suffered wheel damage however it should be repaired to a condition suitable for the reduced speed of operation both in terms of geometry and structural integrity. The reduced speed of operation should not exceed 45 km/h.*
Switch rails squareness		*Note: Switch rails squareness refers to the switch rails being directly opposite each other when checked at the switch rail toes. Out of square switch rails will negatively impact the operability of the switch motor and will result in skewing of switch rodding.*

Table 4-37 Crossing Area Defect Responses

Note: The following does not apply to wheel flange bearing crossing designs.

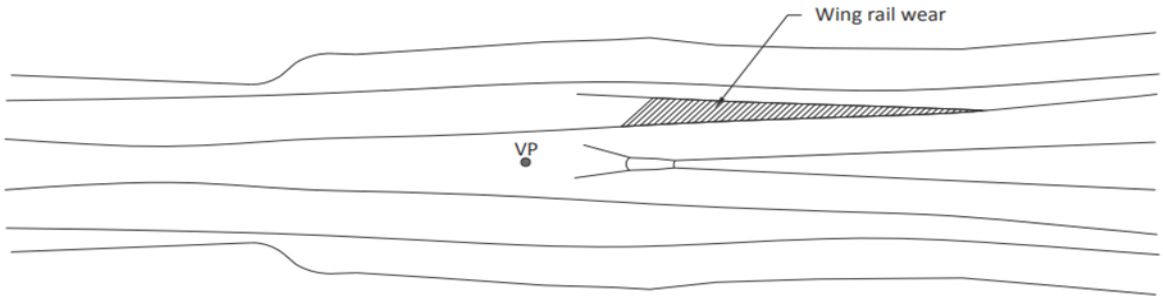
Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Check Rail Effectiveness *Notes: An alternative action to those specified is to prohibit facing train movement.* *The main effectiveness of the check rail is its ability to protect the crossing nose. Wheel contact with the crossing nose is therefore a vital observation to be made during inspections. Any sign of excessive damage to the crossing nose is reason for replacement/adjustment of the check rail regardless of the check rail wear.*				
Nominal	< 1389mm	E	N/A	N/A
	< 1386mm	D	E	N/A
	< 1384mm	C	D	E
	< 1382mm	A	A	A

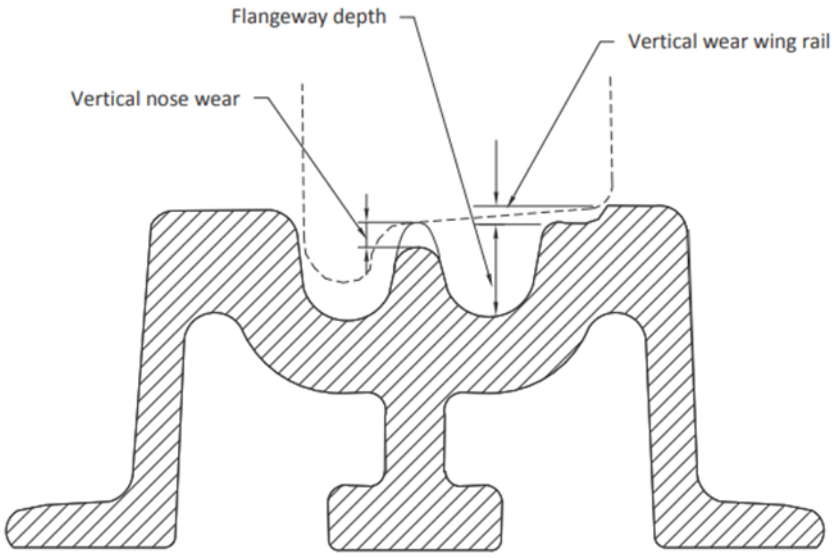




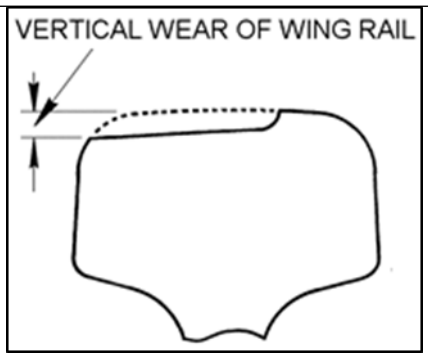
NOTE: Check rail effectiveness should be measured in the vicinity of the crossing nose. A distance equal to 2 times the distance from the Virtual Point to the start of the crossing nose (with the start of the crossing nose as the central point) is the critical area for the crossing.

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Wing Rail				
Vertical wear	> 5mm	E	E	N/A
	>10mm	C	D	E



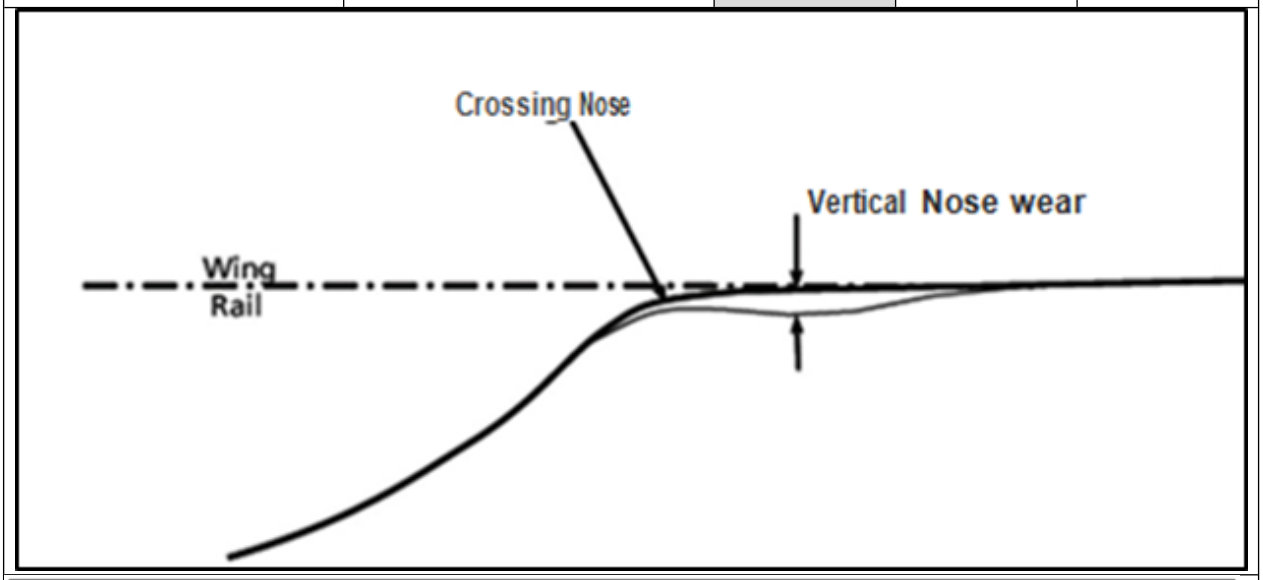


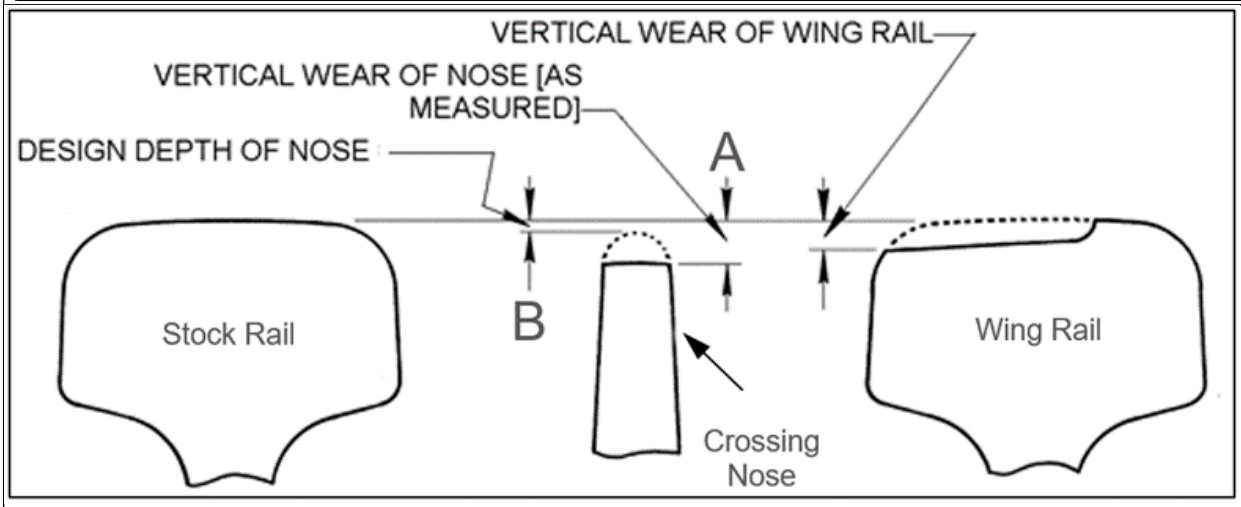
Source: AS7642 – Turnouts and Other Special Trackwork



Wing rail wear shall be measured as the loss of any height in the wing rail at the running band relative to new. The wear can be checked at multiple points across the stock, however the condition is to be taken worst reading observed. Flat spots are to be assessed as wing rail vertical wear.

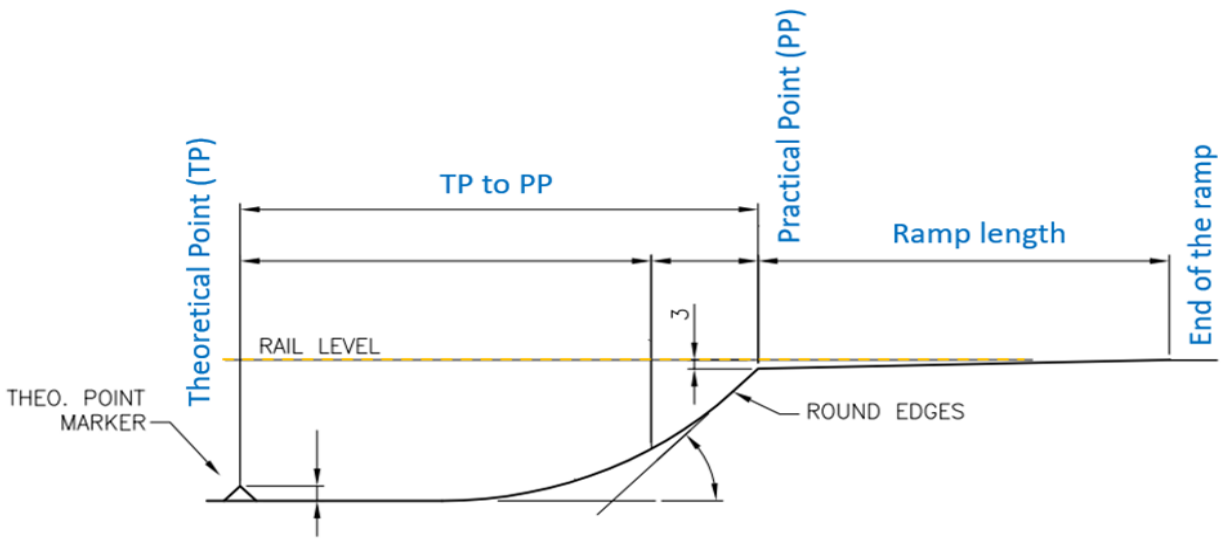
Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Crossing Nose See Appendix for diagram				
Vertical wear	> 5mm	E	E	N/A
	> 10mm	C	D	E





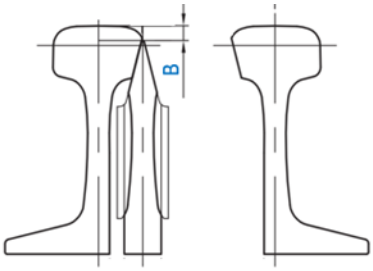
Crossing nose vertical wear shall be taken as the difference in height between the crossing nose and height of the wing rail minus the distance the nose sits below the top of rail.
Dimension A = Difference between stock rail and crossing nose height
Dimension B = Design depth of nose at tip
Crossing Vertical Wear = A – B

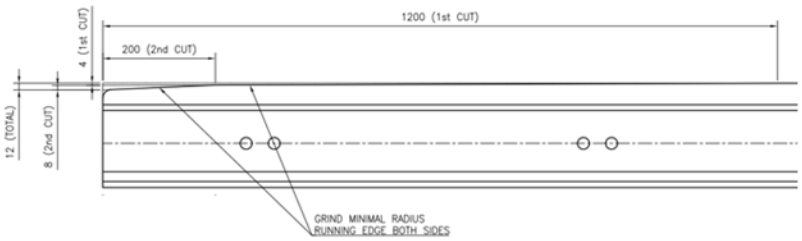
Note: for 1:10 and 1:15 RBM frogs, there is a ramp from the practical point.



RBM Frog	TP to PP (mm)	Ramp length (mm)	Drawing (reference)
1:10	160	127	A0B12500/F
1:15	240	154.83	A0B15484/G

For **SNX Frogs** please refer to the table below:



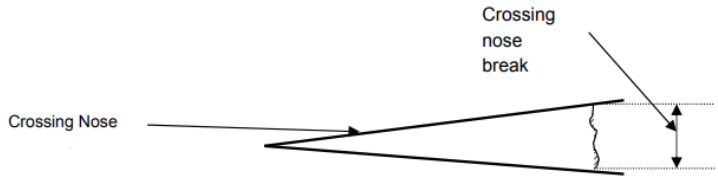


Schematic for 1:20 AREMA VCD and 1:20 Tangential Main SNX Point

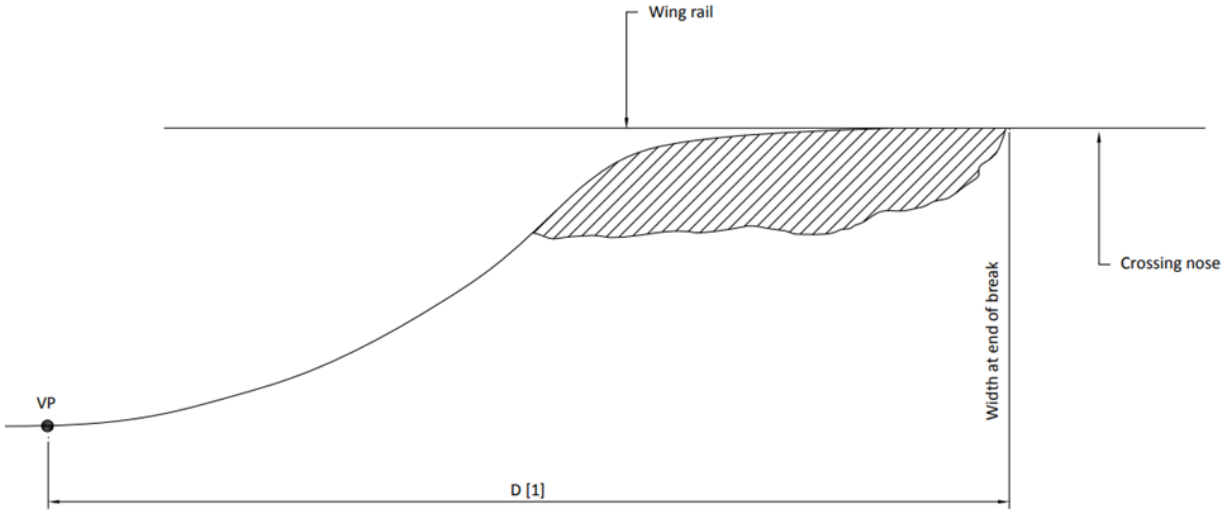
RBM Frog	Dimension B (mm)	Ramp length (mm)	Drawing (reference)
1:10	12	847	A1B14645/G A0B15105/F
1:15	12	1000	A0B14982/F A1B11518/T
1:15 AREMA VCD	0	N/A	A1B17644/A
1:20 AREMA	20	1300	A1B14997/A A0B13952/F
1:20 AREMA VCD	Please see schematic	Please see schematic	A1B17277/J A2B17514/A
1:20 Tangential	Please see schematic	Please see schematic	A1B17277/J A2B17514/A

Note that 1:20 AREMA VCD and tangential SNX has two (2) tapers machined on it.
The first one is 4mm over a 1200mm length and the second is 8mm over a 200mm length equalling a total of 12mm.
Dimension B is measured just behind the radius on the tip.

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Track Gauge *Note: For wide gauge in the crossing critical area plain track limits also apply.*				
Track gauge at the crossing nose	< 1430mm	E	N/A	N/A
	< 1427mm	D	E	E
	< 1425mm	B	C	C
Key Component Condition				
Broken crossing nose within transfer length (width of break)	> 15mm	E	E	N/A
	> 20mm	C	D	E
	> 25mm	A	A	A



Crossing nose breakout width is measured as the width of the widest point the breakout.



Measurement of Crossing Nose Breaks

NOTE [1]: The distance (D) from the virtual point (VP) is defined as follows: D=(Width of the break at gauge line) x (crossing angle), e.g. D=160 mm for a 16 mm wide break on a 1 in 10 crossing.

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Ineffective bearers / fasteners including chair braces and rail plates (in critical area) *Note: Refer to Section 4.4 for the definition of "ineffective" sleepers and fastenings*	1 only	E	E	N/A
	2 consecutive	C	D	E
	> 2 consecutive	A	A	A
Spacer blocks	Broken/cracked	E	E	E

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Cracks in cast crossings	Critical longitudinal or vertical crack that may lead to a piece of crossing eventually lifting or breaking out and affecting the running surface integrity	E	N/A	N/A
	Fully (not affecting the running surface) crack that runs the full section of the crossing such that the crossing is in two pieces, all fastenings are secure and does not impact on the running surface (e.g. Tangential area of crossing)	D	E	N/A
	Fully (affecting the running surface) a crack that runs the full section of the crossing such that the crossing is in two pieces and fastenings are not secure or the break affects running surface integrity	A	A	A
Check rail bolts *Note: The end bolts of all check rails should be effective.*	Loose	E	E	E
	Missing/ineffective: ≤ 2	E	N/A	N/A
	Missing/ineffective: 3	D	E	E
	Missing/ineffective: > 3	B	C	C

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Ineffective crossing bolts	The competent worker should assess individual defects identified for the effectiveness of the bolts. Ineffective bolts include missing or broken bolts. Loose bolts should be tightened. Missing or ineffective bolts should be replaced.			
Crossing Flangeways	Flangeways should be checked for blockages and cleared where blocked.			
Rail defects	Refer to Section 4.3			

4.7. Mechanical Rail Joints

Defects detected in non-welded rail joints should be assessed and reported in accordance with the classification, position and sizing specified in below. The repair of identified defects shall be in accordance with Section 5.5.

4.7.1. Fishplate Cracks and Breaks

Table 4-38 Fishplate Cracks and Breaks

Defect	Track Category 1	Track Category 2	Track Category 3
1 or both fishplates partially cracked	B (24h) (with protection as per comment below)	C (with protection as per comment below)	C (with protection as per comment below)
1 or both fishplates fully cracked	A	A	A

Where one or both fishplates at an insulated rail joint are fully cracked then the joint shall be replaced prior to the next train.

Where one or both fishplates at an insulated rail joint are partially cracked then protection shall immediately be applied. If other track defects exist or the rail joint is considered in a high-risk area (such as at bridges, cuttings and turnouts), a 10 kph TSR should be considered by a competent person. The defect shall be removed within 24 hours. If not removed, it shall be inspected daily at 24-hour intervals, verified fit for rail traffic by a competent person, and documented in 1SAP. If inspections are not completed within any 24-hour window, track shall immediately be closed until it is inspected and deemed safe for traffic.

4.7.2. Missing, Ineffective and Loose Bolts

Note that the table below regarding missing, ineffective and loose bolts at non-welded rail joints considers 6 bolt joint assemblies. Responses relating to a failure of all bolts within the joint can be applied to other size joints.

Table 4-39 Missing, Ineffective and Loose Bolts

Defect	Track Category 1	Track Category 2	Track Category 3
1 missing, ineffective or loose bolt	E (6w)	E	N/A
2 missing, ineffective or loose bolts	C (14d)	D	E

Defect	Track Category 1	Track Category 2	Track Category 3
3 or more missing, ineffective or loose bolts	B (24h)	C	C
All bolts loose but with sufficient integrity to provide vertical & lateral support	B (24h)	C	C
All bolts loose without sufficient integrity to provide vertical & lateral support	A (24h)	A	A

4.7.3. Joint Gap

Note that the following table only applies to non-insulated rail joints. As such Track Category 1 and Track Category 2 responses relate only to temporary rail joints formed using fishplates and clamps. Insulated rail joint gap failure will be in the form of closure of the gap or loss of insulation, resulting in failure of electrical insulation and is therefore covered in Table 4-41 .

Table 4-40 Non-Insulated Non-Welded Rail Joint Gap Defects

Defect	Track Category 1	Track Category 2	Track Category 3
Gap > 15mm	B	C	E
Gap > 20mm	B (24h)	C	C
Gap > 30mm	A (24h)	A	A

Where joint gap defects are identified a competent inspector shall check for fishplate and fishplate bolt defects (especially broken bolts), visible rail discontinuities and defects, and stress control problems, and take appropriate actions for the defects found.

Where joint gap is found to be greater than 30mm then a competent inspector shall review risk of wheel climb (track curvature, horizontal angle at joint, foulness of joint, joint vertical and lateral integrity) during assessment of the required protection prior to opening to rail traffic.

4.7.4. Electrical Insulation

Note that the following table is applicable only to insulated rail joints.

Table 4-41 IRJ Electrical Insulation Defects

Defect	Track Category 1	Track Category 2	Track Category 3
Failure of Electrical Insulation	A	A	A

4.7.5. Rail End Post Wear

End post wear shall be measured using a 100mm straight edge positioned longitudinally on the crown of the rail head, centred at the rail joint. A Starret gauge shall be used to measure the depth from straight edge to the rail head at the end of each rail.

Table 4-42 Rail End Post Wear

Defect	Track Category 1	Track Category 2	Track Category 3
Rail end batter > 2mm	E	E	E

Defects of these sizes will result in increased maintenance requirements and may result in deterioration of components such as the rail joint, sleepers and ballast due to high impact loads.

Increases in the defect response may be required where the rail end post defect causes defects in other assets and parameters. When rail end post defects exist, the competent inspector shall ensure that track deflection (pumping) and track geometry are checked for defects as a minimum and appropriate responses implemented.

4.7.6. Rail Joint Deflection

Deflection of a rail joint is the movement experienced by the rail joint under loading. Maximum deflection will be experienced under the passage of a loaded ore train. Deflection can be measured by various methods including, but not limited to:

- Void meters.
- Instrumented ore car.
- Laser and rail mounted target; and
- Strain gauge.

It should be noted that different methods of measurement yield different readings with different accuracy. This should be considered in choosing an appropriate method and when calibrating readings.

Table 4-43 Rail Joint Deflection Defects

Defect	Track Category 1	Track Category 2	Track Category 3
Deflection > 7mm	E (6w)	E (6w)	N/A
Deflection > 12mm	D (2w)	E (2w)	E

4.8. Bridges and Culverts

The integrity of structures should be assessed to verify their capacity to safely perform the required function. Assessment of required responses and subsequent actions should be in line with the requirements detailed in Section 3.13 and with documents specified in Section 2.11 of this Code of Practice, and be performed by a suitably qualified engineer.

Temporary speed restrictions applied to track passing over under-track structures may be considered to manage:

- Dynamic loading experienced by the structure.
- Risk of derailment on the structure; and
- Safe execution of works or inspections on the structure.

The suitably qualified engineer shall be required to identify the required speed restriction to be applied to manage risks associated with the structure. The BHPIO Rail Rule Book shall also be consulted for direction on safely executing works and inspections.

4.9. Signs

Each sign should be assessed to ensure compliance with the required standards for the installation.

Where the sign installation site is assessed and does not comply with the required standard, appropriate action should be taken to ensure the immediate safety of operations. Follow up action should then be taken to ensure that the required standards are complied with.

Any amendment of signage should be carried out in accordance with the Management of Change procedures.

Where it is assessed that the sight line is obstructed appropriate action should be taken to ensure the immediate safety of operations. Follow up action should then be taken to ensure that the sight line is restored.

Where the sight line is permanently obstructed for the maximum operating speed then either:

- Advance warning to drivers of trains should be provided.
- The sign should be relocated; and
- Operational restrictions should be imposed.

Table 4-44 Sign Repair Timeframes

Application	Sign Type	Repair Timeframe
Safety Signage	Temporary Speed Restriction (TSR)	48 hours
	Worksite Protection	
	Level Crossing Signage for Road Users	
Operational Signs	Location Boards	7 days
	Block Point Sign	
	Permanent Speed Sign	
	Clearance Point Sign	
	Whistle Sign	
	Yard Limit Sign	
	Limit of Shunt Sign	
	Attend to Derail Sign	
	Change to Operation Systems or Operational Parameters (Such as RTS, radio channels etc.)	
Other Signage	Kilometre Post Sign	28 days
	Structure and Equipment Identification Sign	
	No Trespassing Sign	
	Property Boundary Sign	
	Maintenance Boundary Sign	

4.10. Clearances

Clearances should be assessed against the clearance standards adopted for each track section. Where the standard is infringed either:

- Action should be taken to restore the clearances such that the standard is not infringed, with clearances monitored until this action is completed; or
- Approval should be sought to register the clearance location as a permanent infringement of the standard following detailed clearance assessment.

Where permanent infringement of the standard for clearances has been permitted the results of inspections should be assessed to determine whether the track tolerances used to specify the clearance standards have been exceeded. Where the track tolerances have been exceeded either:

- Action should be taken prior to the passage of the next train, to restore the track position such that the track tolerances are not exceeded; or
- Restrictions should be applied to operations, prior to the passage of the next train, until action can be taken to restore the track position.

Refer to section 2.15 for further information on Clearances.

4.11. Guard Rails

The responses to guard rail defects are shown below. Note that any defect identified shall, if possible, be rectified immediately otherwise the appropriate response as shown below shall be adhered to. Rectification works shall be completed within 28 days of identification of the defect.

Table 4-45 Guard Rail Defects

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Sleeper Fastenings Missing or Ineffective	> 25% are missing or ineffective on either side of the guard rail	E (28d)	E (28d)	E
	For splay rails or the ends of guard rails > 2 are missing or ineffective on consecutive sleepers	E (28d)	E (28d)	E
Component Damage	Any damaged components which may render the guard rail ineffective in the event of a derailment	E (28d)	E (28d)	E
Rail Joint Condition	Ineffective Rail Joint	E (28d)	E (28d)	E

4.12. Derailers

Derailers shall be replaced if showing any signs of damage from rolling stock impact.
The minimum rail head height shall be 180 mm where wheel crowders are in use on concrete bearers.
Derailer rectification works shall be completed within 42 days of identification of the defect.

If derailer is found not installed as per the manufacturer's recommendation, then it shall be adjusted as required.

Table 4-46 Derailer Defects

Parameter	Defect	Track Category 1	Track Category 2	Track Category 3
Any	Impact Damage	N/A	E (42d)	E (42d)
Rail Head Height where Wheel Crowders are in use on Concrete Bearers	< 180 mm	N/A	E (42d)	E (42d)
TMAN specifications	Out of installation spec	N/A	E (42d)	E (42d)

5. Activities (Maintenance Strategy)

5.1. Rerail

5.1.1. Activity

Rerail is the activity of replacing long lengths of rail, including pads, insulators and if appropriate, clips. Rail is typically replaced in lengths of 400m continuously welded rail, delivered to site by a steel train. Partial lengths of tangent track can be rerailed however rerail of curves shall extend to the tangent track at each end of the curve.

5.1.2. Strategy

Rail shall be replaced based upon the following conditions:

- The extent of rail wear is approaching the wear limits; and
- Rail surface condition.

Clips shall be replaced in the following situations:

- On all curves being rerailed.
- Where the clips show visible signs of corrosion or damage.
- Where there is evidence of rail creep; and
- Where toe load testing identifies inadequate toe loads.

Prior to a rerail activity new rail shall be laid in the centre of track in the correct location, with individual strings overlapped by 1m at either end.

5.1.3. Reference Documents

Document Reference / ID	Title / Description
SPEC-000-C-12007	Heavy Haul Rails
WIN - 0109654	Fixed Flashbutt Welding Operations
WIN - 0102849	Mobile Flashbutt Welding
WIN-RTS-RTM-127	Aluminothermic Welding
WIN-RTS-GEN-001	Steel Train - Loading of Long Welded Rail with Gantry Cranes
WIN - 0106222	Unloading Rail Steel Train
WIN - 0106278	Picking up Rail Steel Train
WIN - 0104402	Re-rail Operations
WIN-RTS-RTM-129	Re-railing (Lengths of 25m or less)
WIN - 0096245	Replace Rail

5.2. Cutting Rail

Rail saw cutting is the preferred method of cutting rail and it is the only method permissible for preparation of closure rails to be welded into track. Cutting of rail shall be carried out as per the specified procedure (WIN-RTS-RTM-177).

Rail ends should be cut square to defined tolerances depending on the purpose of the cut. Cuts should be made a minimum of 50mm from the end of the visible tip of any crack ends.

The first cut in to CWR shall be made by flame cutting. Rail saw cuts in this instance are prohibited. Flame cutting of rails shall conform to WIN-RTS-RTM-104 and be subject to the conditions set out below:

- Flame cut rail should be trimmed using a rail saw. A minimum of 30 mm should be cut off the cooled rail ends immediately prior to welding, rail with flame cut ends should be inspected for signs of visible cracking prior to saw cutting.
- Flame cutting may not be used in preparing rail ends for installation of a permanent non-welded rail joint; and
- Both ends of the rail to be welded must be of the same condition i.e. both sawn. Rail saw cutting must be performed prior to welding or plating rail.

5.2.1. Reference Documents

Document Reference / ID	Title / Description
WIN-RTS-RTM-177	Use of Rail Saw
WIN-RTS-RTM-104	Use of Oxy & Propane Gas

5.3. Drilling Holes in Rail

Rail drilling shall be carried out as per the specified procedures (WIN-RTS-RTM-106). The drilling of holes in rails shall be minimised as far as practicable, e.g. by using rail mounted equipment that does not require drilling of the rail.

Marking the centre of the hole to be drilled shall be carried out using an appropriate template or equivalent. Holes shall be drilled square to the web via the use of an appropriate guidance mechanism.

Drilling operations require appropriate cooling of the drilling tool.

Under no circumstance 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 shall be within 5 mm of the neutral axis.

The minimum distance allowable between the outer edge of a bolt hole and a weld is 80mm. Diameter for holes drilled in rail:

- Guard Rails: 38mm (1 1/2”).
- Insulated Joints: 28mm (1 1/8”).
- Fish Plates: 32mm (1 1/4”).
- Blades: 32mm (1 1/4”).

Where drilling is required, the drilling process should be controlled so as not to metallurgically or mechanically damage the rail. Any resulting burrs and projects shall be removed.

5.4. Rail Repairs

5.4.1. Activity

Rail repair is the activity of removing rail defects at a specific location and is likely to be carried out only on a single rail at that location. The method of repair can vary, as discussed below.

Rail repairs shall be carried out in accordance with Section 5.1 and Section 2.2.1.6.

When cutting broken rail from track, ensure that all cracks have been removed, and the repair plug should be centrally positioned over the break location.

5.4.2. Strategy

The approach to repair of defective rails and welds shall be carried out in accordance with Table 5-1 below. When a defect is to be removed consideration should be given to removal of any identified rail and weld defects in the vicinity. The rail removed shall be immediately rendered unable to be reused.

Table 5-1 Rail and Weld Repair Strategy

Rail Defect Type	Strategy
Surface Defects	
Dip in running surface	The rail containing the defect shall be removed and replaced or the defect shall be removed by lifting
Peak in running surface	The rail containing the defect shall be removed and replaced or the defect shall be removed by grinding
Vertical deviation in rail running surface (Ramp angle)	
Vertical step in rail running surface	
Horizontal step in rail running surface	
Wheel burn	Monitor and protect if required.
Weld defects in repairs of surface defects	NDT 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
Other Defects	
Gauge widening due to change in rail	The rail containing the defect shall be removed and replaced or the defect shall be removed by bending the rail

Rail Defect Type	Strategy
Gauge narrowing due to change in rail	The rail containing the defect shall be removed and replaced or the defect shall be removed by grinding
Gauge face angle exceeds defect limits over a length of more than 2m	

Rail Defect Type	Strategy
Bolt hole (crack, elongation or non-conforming)	The rail containing the defect shall be removed and replaced
Broken foot	
Broken rail	
Corroded rail	
Notches	
Weld defect (head, web or foot)	
Weld defect: surface (e.g. gas hole, hot tear, shrinkage, porosity)	
Derailment damage	
Transverse defect (including those from shells or wheel burns)	
Foot/web separation and head/web separation	The complete rail between welds shall be replaced unless the rail has been examined in detail by manual Non-Destructive Testing (NDT) examination to determine the extent of the defect
Horizontal split (head or web)	
Mill defect	
Multiple transverse defects	
Piped rail	
Vertical split (head or web)	
Mechanical joint defect	The necessary repair should be determined by a competent worker and may include replacing the joint, replacing bolts, replacing plates
Unclassified defect	The necessary repair should be determined by a competent worker

Rail Defect Type	Strategy
Rail surface (e.g. rolling contact fatigue)	The necessary repair shall be determined by a competent inspector and include consideration of the location, extent and the impact on the ability to carry out NDT of the rail affected
Weld defects in repairs of surface defects	The necessary repair should be determined by a competent worker

5.4.3. Reference Documents

Document Reference / ID	Title / Description
WIN-RTS-RTM-129	Re-railing (Lengths of 25m or less)
WIN-0096245	Replace Rail
WIN-RTS-RTM-076	Clamp Rail Defect
SPR-RTS-GEN-001	Broken Rail Procedure
WIN-RTS-RTM-106	Rail Drill (Operation of Rotor-broach)
WIN-RTS-RTM-107	Rail Drill (Operation of)

5.5. Non-Welded Rail Joint Repair

5.5.1. Activity

The repair and installation of non-welded rail joints varies depends on the severity of defects at the joint. Often multiple defects need to be rectified to ensure that the joint remediation works are successful. These may include rectifying issues with ballast, sleeper, and rail surface rail joint end batter.

5.5.2. Strategy

Based upon deflection measurements obtained during inspections assessed against defect thresholds the following remediation works shall be carried out:

Table 5-2 Non-Welded Rail Joint Repair

Defect	Maintenance Activity Required	Timeframe
Deflection > 7mm	Replace ballast if condition exceeds thresholds, Re-space sleepers (if required), Repair or replace rail joint, Restore ballast profile, Hand tamp joint	Within 6 weeks
Deflection > 12mm	Replace ballast if condition exceeds thresholds, Re-space sleepers (if required), Repair or replace rail joint, Restore ballast profile, Hand tamp joint	Within 2 weeks

Where rail defects relating to the condition of the joint rail surface and/or end batter and/or joint gap exist then the defects shall be removed by grinding. If grinding is not sufficient to remove the defects then the rail joint shall be replaced and activities shown in the table above shall be followed.

Note that these actions relate only to the rectification requirements. Immediate defect response is still required as per Section 4.7.

5.6. Repair Welds

5.6.1. Activity

Manual metal arc, gas metal arc and flux cord arc welding processes are used to repair rail surfaces by introducing and building up weld material on the rail surface. Welding processes shall be carried out in accordance with WIN-0087657 and WIN-0087658. All materials shall be supplied in accordance with relevant Australian Standards or equivalent BHPIO specifications and tested and approved prior to use on the BHPIO Railroad and supported by Welding Procedure Qualifying Records and Welding Procedure Specifications.

The welder executing the weld shall be fully trained, competent and hold current certification and VOC to weld on the BHPIO Railroad.

Welders and welding equipment shall be audited for compliance on a frequency not exceeding 1 year. More frequent assessment may be required where evidence of non-conformance is identified. Corrective actions in the event of non-conformances may include:

- Withdrawal of the welder certification.
- Reassessment of the welding process; and
- Retraining of welder.

Weld quality is initially confirmed by the welder by means of visual observation of the welding process and by completion of a visual inspection and magnetic particle test after weld installation. This shall be carried out by the welder for every weld installed prior to allowing unrestricted traffic. When a process non-conformance is identified possible corrective actions include:

- Stopping the welding activity.
- Reassessment of the welding process; and
- Rework including potential installation of a new rail plug.

All repair welds with a depth greater than 5mm shall be internally non-destructively tested as per Section 3.11 within 14 days of installation to track.

5.6.2. Strategy

Rail surface repairs shall be carried out at the nose and the wing rails of crossings when defect thresholds in Section 4.6 are exceeded and in lieu of replacement of the crossing.

5.6.3. Reference Documents

Document Reference / ID	Title / Description
WIN-0087657	Turnout Welding RBM
WIN-0087658	Turnout Welding SNX

5.7. Tamping

5.7.1. Activity

Tamping involves moving the track (rail and sleepers) into the required position to achieve the required track geometry. The ballast layer beneath the sleepers is then rearranged to provide support to maintain the desired track position. Re-positioning of the track is carried out by use of either powered mechanical tamping machines or manually with the use of jacks. Rearrangement of the ballast is achieved using vibratory equipment penetrated into the ballast layer, either as part of the powered mechanical tamping machine or by use of handheld vibratory tampers.

All tamping activities shall comply with the BHPIO procedure for Tamping Strategy, doc number 0129504.

Tamping degrades the ballast which decreases its effectiveness so it is important to ensure that maintenance practices and strategies minimise the disturbance of the ballast while maintaining track geometry.

5.7.1.1. Mechanical Track Levelling, Alignment and Tamping

Ballast shall be tamped using an approved means of powered mechanical vibration and in accordance with the appropriate procedure.

Both ends of the sleeper shall be tamped simultaneously, both inside and outside of the rail seat area and a minimum lift of 18mm shall be applied.

Under normal circumstances and standard ballast condition, in order to achieve a good and durable tamping quality, the distance between the bottom of the sleeper and the top of the tamping tine spade should be approximately 20mm.

5.7.1.2. Manual Track Levelling, Alignment and Tamping

Manual methods of track levelling, aligning and tamping are permitted for spot repairs. Ballast shall be firmly packed under the rail seat area for a distance of not more than 300mm out from each side of the rail foot. This is to ensure that centre loading of the sleeper does not occur. Ballast shall be tamped using approved equipment types following the appropriate procedure WIN-RTS-RTM-100.

Correction of track geometry defects by shimming on ballasted track is not permitted.

5.7.1.3. Levelling, Alignment and Tamping of Turnouts

Tamping turnouts shall meet the standards for plain line track. Bearers should be tamped over their full length when any part is lifted. Bearers should be lifted in an even horizontal manner, or to the designed superelevation as applicable.

Tamping shall extend from the switch to encompass both the arrival and departure insulated rail joint locations, and extend a minimum of 10m beyond.

5.7.2. Strategy

Possessions for plain line and turnout tamping should be planned on cyclical basis, based upon historic work requirements. Specific sites requiring tamping shall be identified using track geometry condition data. Standard deviations for Top (vertical alignment) should be the primary driver for identifying sites requiring tamping and any site with a standard deviation quality band of ‘T3’ or ‘T4’ should be prioritised.

For plain line tamping, the minimum site length shall be 1km. The geometry left behind should be recorded using the rear trolley and checked for compliance with required quality.

When extreme weather events are forecast to impact the BHPIO Railroad then tamping machines and associated ballast wagons should be stabled towards each end of the network in locations that are not susceptible to flooding for the purpose of repair of any potential wash-away.

Further to the above, a more comprehensive tamping strategy should be developed providing detailed guidance on follow up tamping regimes related to track maintenance and renewal activities.

5.7.3. Reference Documents

Document Reference / ID	Title / Description
0129504	Tamping Strategy - Procedure
WIN-RTS-RTM-100	Hand Tamping (Hydraulic, Pneumatic & Petrol)
WIN-0109975	Condition Based Switch Tamping Inspection
WIN-0109976	Condition Based Tamping Inspection

5.8. Grinding

5.8.1. Activity

Rail grinding is a maintenance process whereby a vehicle or train is used to install/restore the required profile to the head of the rail and control surface defects and irregularities. This activity extends the life of the rail and improves the wear behaviour of both the rail and the rolling stock wheels.

All rail grinding works should be carried out in accordance with the BHPIO Procedure for Machine Profiling of Rails – Plain Track and Turnouts, Doc No. 0131231.

5.8.2. Strategy

Rail grinding requirements are linked to the volume of rail traffic passing over the rail. As such, the frequencies for rail grinding are specified based upon Million Gross Tonnes (MGT) of traffic traversing the track section. Variations to the frequencies also occur based upon the curvature and gradient of the track.

Track geometry condition impacts on the wear of the rail profile and as such poorer track geometry can result higher demands for grinding. The following table details the grinding requirements for all track.

Table 5-3 Rail Grinding MGT Frequencies

Curvature	Loaded Grade*	Frequency**	Minimum Metal Removal
Curves < 1000m	All	15 MGT	0.2mm 0.4mm where spalling is present
Curves ≥ 1000m and < 3500m	All	15 MGT	0.1mm
Curves ≥ 1000m and < 3500m	All	30 MGT	0.2mm
Curves ≥ 3500m to Tangent	All	30 MGT	0.1mm
Curves ≥ 3500m to Tangent	≥ 0.2	45 MGT	0.2mm
Curves ≥ 3500m to Tangent	< 0.2	60 MGT	0.2mm
Turnouts*** (Preferred Interval)		30 MGT #	As per document 0131231
Turnouts*** (Max Interval)		45 MGT	As per document 0131231
All newly installed rail		Initial grind from install: ASAP or ≤ 8 MGT for both plain track and turnouts	As required for ⅓ profile
		16 MGT from install	As required for ⅔ profile
		24 MGT from install	As required for full profile

**Note-1 that the requirement related to grade makes the assumption that loaded trains travel towards port. For parts of the BHPIO railroad where this is not the case, then the direction of loaded travel shall be considered in assigning grinding frequencies*
***Note-2 Grinding may be carried out at either low MGT values with corresponding lower metal removal or alternatively at the higher MGT values with associated higher metal removed.*
****Note-3 Turnouts in TC-3 areas shall be subject to minimum annual detailed inspections – and grinding carried out as required based on these inspections.*
 # Note-4 where the 30MGT interval for turnout grinding is not met, monitor and grind prior to 45MGT with additional metal removal based on condition.

Rail grinding cycles shall be undertaken within a tolerance of +/- 3 MGT or 20% of the cycle, whichever is larger. Exceedance of the specified grinding cycle may result in the need for corrective grinding. The minimum metal removal values should be used where there is no detectable RCF (surface condition) and the profile is compliant with profile limits, otherwise greater metal removal is required.

Notwithstanding the requirements in Table 5-3, grinding of the turnout diverge legs shall occur at every second through movement (straight leg) grinding interval irrespective of actual railed tonnage in order to help control stock/blade height and maintain even wear throughout the turnout. In some instances Table 5-3 provides two different frequencies and metal removal rates. In these instances the rail grinding strategy may be set to whichever creates a better business outcomes based upon the availability of track time and the capability of the grinding equipment.

Rails through level crossings are to be ground at the same frequency as the rails either side of the level crossing, in accordance with Table 5-3.

Note that wayside asset protection systems that impact on the ability of the grinding machine to carry out rail grinding are not considered as special sites; however, this equipment shall be removed from track during grinding activities to ensure that works can be carried out.

5.8.2.1. Grinding Newly Installed Rail

Newly installed rail in plain track shall be first ground as soon as possible after installation, however, not exceeding the cycles specified in Table 5-3.

Newly installed turnout rails should be first ground as soon as possible or within 8 MGT after installation to avoid high early damage, as specified in Table 5-3.

The conversion of new rail profile for plain track and turnouts may be staged over three shortened grinding cycles, as specified in Table 5-3 and the BHPIO Machine Profiling Procedure (Doc No. 0131231).

Additional corrective grinding may be required if the above requirements cannot be achieved within the specified cycle tolerance.

5.8.3. Reference Documents

Document Reference / ID	Title / Description
0131231	Machine Profiling of Rails – Plain Track and Turnouts

5.9. Rail Stress Control

Rail stress should be monitored and controlled to ensure that the rail is maintained within a design neutral (stress free) temperature range as specified in Section 2.2.

5.9.1. Activity

Assessment and, if necessary adjustment shall be carried out whenever the following events occur:

- New or recycled rail is being laid into track; and
- A stress check is being carried out.
- The rail adjustment is suspected out of tolerance, for example due to the presence of:
    - Buckles.
    - Break-aways / pull-aparts.
    - Significant skewing of sleepers.
    - Mechanical joint failure.
    - Significant rail creep observed by bound switches or creep pegs.
    - Significant changes in track alignment; and
    - Installation of rail into track outside of the design stress free temperature.

CWR that is being stress adjusted should be subject to the following maximum adjustment lengths:

Table 5-4 Stress Adjustment Based on Curve Radius

Curve Radius R (m)	Maximum Stressing Length (m) (pull in one direction) Without under head rollers	Maximum Stressing Length (m) (For stressing at DSFT) With under head rollers
R ≥ 2000 and tangent	800 (400)	TBD
2000 > R ≥ 1600	500 (250)	TBD
1600 > R ≥ 400	300 (150)	TBD
R < 400	150 (75)	TBD

Note that the actual adjustment length will depend on equipment and practices used to ensure an even distribution of the adjustment over the adjustment length.

5.9.2. Reference Documents

Document Reference / ID	Title / Description
0130701	Rail Stress Management Procedure

6. Terminology

Term	Description / Definition
ALCAM	Australian Level Crossing Assessment Model
ATW	Aluminothermic Weld
Active level crossing	Level crossings incorporate devices such as flashing lights, boom barriers and bells to warn road users of the approach or presence of rolling stock
Back track	A section of line, other than a running line, used for shunting and the storage of rail vehicles
Bearers	A type of sleeper used under turnouts and special track. Bearers are generally larger in dimension than standard sleepers to provide support for both tracks as well as the increased loading experienced under such track structures
Cant	The difference in level between the two rails of a track on a curve. Also known as Superelevation
Catchpoint	A single or double blade switch placed on a siding to protect the mainline/running line by derailing rail traffic that may enter or foul an adjacent running line
Check rails	Rails within a fixed crossing to guide the wheels the correct side of the crossing nose
Clearance	The distance between the nearest points of vehicles on adjacent tracks or from the nearest point of a vehicle to the face of an adjacent structure
Closure Rail	Rails making up a turnout or special track diamond configuration that are apart from those in the switch assemblies, crossings and checkrail units.
Competence	The possession of skills and knowledge, and the application of them to the standards required in employment
Converging (tracks)	Tracks meeting and joining to become one
Crosslevel	The difference in the rail level of the two rails in a track
Crossing	A track component that enables a wheel travelling along one rail to pass through the rail of a track which crosses its path. Also known as a ‘Frog’
Crossing loop	See Passing Track
Crossover	A means by which trains pass from one track to an adjacent track. A crossover is constructed from two turnouts, one on each track facing opposite directions
CWR	Continuously Welded Rail
Derailer	A device used to prevent fouling or track occupation by unauthorised movements of trains or unattended rolling stock. It operates to lift the leading wheels of rolling stock and force them over the rail on which the derailer is mounted.
Diverging track	Dividing into two tracks
Diverging line	Dividing into two lines
Dragging Equipment Detector (DED)	A device fitted at rail height to detect any equipment dragging from a rail vehicle
Duplicated track (Bi- Directional)	Duplicated track sections permit rail traffic to follow, pass, cross, overtake or be routed around track obstructions and must not to be confused with loops
Failure	The consequence of a fault or error
Fastening	A combination of base plates, and fasteners used to attach the rail to the bearer
Fault	A defect in a system, product or other change which may cause an error

Term	Description / Definition
Fishplate	A metal joint bar used to connect adjacent rails. Refer to AS 1085.2
Formation	The full width of the top of embankments or the bottom of cuttings upon which the track is constructed
Frog	See Crossing
Gauge	The distance between the inside running (or gauge) faces of the two rails, measured at the gauge point.
Gauge face / Gauge line	The running side of a running rail
Guard rail	A rail (inside or outside the running rail) used to restrain lateral movement of a derailed wheel-set. Used to protect structures or control the lateral movement of the wheel-set on bridges or in other higher risk situations.
Heel block	Single or multiple blocks, depending on switch type, that rigidly fix the switch rail to the adjacent rail in the correct geometric configuration
Heel joint	The joint around which a pivot heeled switch rotates. The joint is made up of a steel block with fishplates and bolts which are designed to allow this movement
Hi-rail	A rubber tyred road / rail vehicle fitted with retractable rail wheels that can be readily placed on or removed from track at suitable locations
Hot Bearing Detector (HBD)	Hot Bearing Detector. (Sometimes called a Hot Box Detector). See track warning equipment
Hot Wheel Detector (HWD)	See track warning equipment
HSE	Health, Safety, Environment. Standards that aim to protect employees, the public, the environment and to comply with applicable laws to protect the Company's reputation.
IBR	In bearer rodding
Insulated Rail Joint (IRJ)	A rail joint manufactured from components and assembled such that the joined rails are electrically insulated from each other
Kilometre Location	The distance in kilometres from a set point, used to identify a specific place in a section
Level crossing	A level crossing is a location where the rail line and a road or pedestrian walkway cross paths on the same level
LH / RH	Left Hand / Right Hand
LWR	Long Welded Rail
May	Denotes an option that is permitted
MGT	Million Gross Tonnes
Mini-plug	A temporary form of rail defect removal. The process involves cutting out a small portion of rail (containing the defect) and replacing it with a piece of rail of the same profile, type and wear. Mini-plugs are secured in track using mechanical joints.
NDT	Non-destructive Testing
Neutral temperature	The rail temperature at which the track has no longitudinal thermal stresses
Passing track	A track, secondary to the mainline track, provided primarily for crossing or passing train, track maintenance and rail vehicles
Passive level crossing	Level crossings rely on the road user to detect the approach or presence of rolling stock by direct observation
PMI	Preventative Maintenance Instruction
Points	See Switch
Portable Derailer	See temporary derailer.
Rail defect	A surface or internal fault in the rail which may affect the serviceable life of the rail

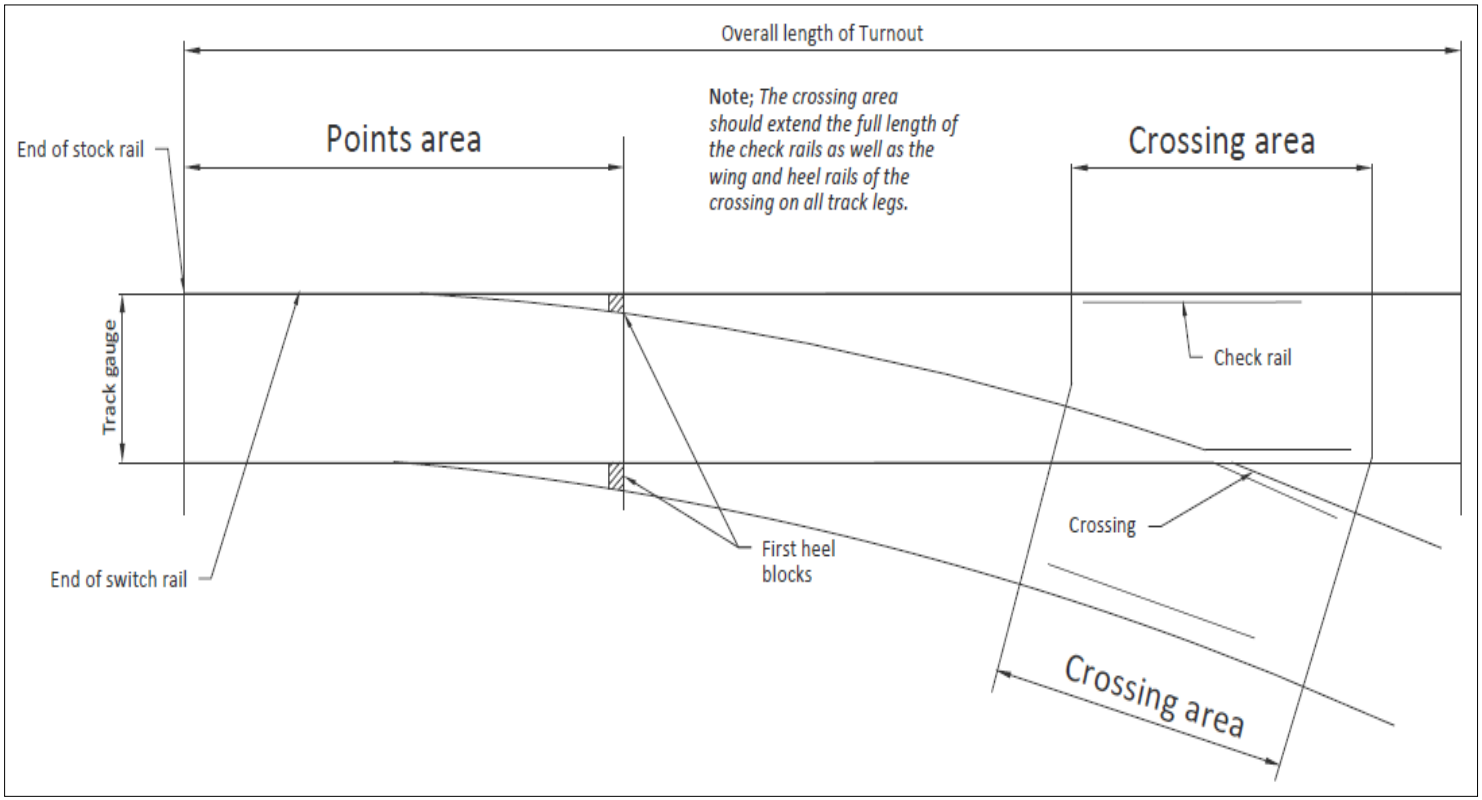
Term	Description / Definition
Rail cant	The angle at which running rails are inclined from vertical to the plane of the track
Rail head	That part of the rail which provides a running and guiding surface for the wheel
Rail–head hardened	Rail which has had the head heat treated after rolling to increase the hardness. Refer to AS 1085.1
Rail—joint—Mechanical	A rail joint made by mechanical means (as opposed to welding), generally using bolted fishplates
Rail network	Rail lines vested in and owned by BHP Iron Ore including passing loops and turnouts from those lines and associated rail infrastructure facilities including rail yards and load-outs. All areas within 3 metres of the nearest rail of any line
Rail web	The vertical section of the rail that joins the head to the foot
RBM crossing	Rail Bound Manganese crossing
RCF	Rolling Contact Fatigue
Resilient fastenings	Resilient fastening assemblies provide a flexible restraint that holds the rail in position on the sleeper or other support structures by providing a spring force of known magnitude
Rolling stock	Any vehicle that operates on or uses a rail track, excluding a vehicle designed for both on and off track use. A collective term for a group of cars of various types, including locomotives
RRB	Rail Rule Book
Safeworking	System of operating rules and procedures for the safe operation of rail vehicles and the protection of people and property on or in the vicinity of the rail
Safeworking Procedure	An approved written procedure for the execution of specific tasks and associated safety requirements
Shall	To be understood as mandatory
Should	Indicates a recommendation.
Siding	See back track
SNX	Swing Nose Crossing
Speed restriction	A reduction of the maximum permitted speed for a specified portion of the track
Stream Flow Detector (SFD)	See track warning equipment
Superelevation	The difference in level between the two rails of a track on a curve. Also known as Cant
Switch	A switch assembly consists of either a right and left hand switch and stock rail, complete with associated plating and fastenings
Switch and crossings	See Turnout
Switchblade	A machined tapered rail that allows the direction of a train to be altered to another line
TCI	Track Condition Index
TCMS	Track Condition Monitoring System
TCMV	Track Condition Monitoring Vehicle
Temporary Derailer	A derailer that clamps directly to the rail as opposed to derailers that are mounted onto sleepers, bearers, concrete pads or ties.
Track	The guidance system (rails) on which the rolling stock travels and its immediate support which may include rail connectors, sleepers, ballast, switch and crossings, and substitute devices where used
Track buckle	A substantial misalignment contributed to by longitudinal thermal stresses overcoming the lateral resistance of the track

Term	Description / Definition
Track geometry	The vertical and horizontal alignment, cross level and superelevation of the track
Track Maintenance Machine (TMM)	A self-propelled rail vehicle used solely for the maintenance of the railway
Track section	Any portion of track, the limits of which are defined by switch locations
Track speed	The maximum allowed train speed for a portion of track
Trackside Monitoring Equipment	Devices that monitor and respond to track, and rail vehicle conditions. (See trackside warning equipment)
Trackside warning equipment	Those devices installed at various sites on track to detect and report on the condition of the track and passing rail traffic as they pass the detector location. These include: • (ABD) acoustic bearing detector. • (CRD) cold rail detector. • (CWD) cold wheel detector. • (DED) dragging equipment detector. • (HBD) hot bearing detector. • (HWD) hot wheel detector. • (SFD) stream flow detector; and • (WIM) wheel impact monitor
Train control	The control of trains by supervision of train running operations, coordination and forward-planning of all elements of the rail system within the specified boundaries. Includes the monitoring of all traffic operated within the network to standards specified
TSR	Temporary Speed Restriction
Turnout	A complete track assembly that allows rolling stock to converge or diverge into or from a single track (respectively). A turnout consists of the following: (a) Switch assembly. (b) 'V' Crossing. (c) Checkrails. (d) Closure rails. (e) Bearers. (f) Plates, fasteners and rail joints; and (g) Switch operating equipment.
Twist	The change in the cross level between two track locations separated by a nominated distance interval
VCD	Vossloh Contained Device
VOC	Verification of Competency
Work Instruction (WIN)	Documents which describe how a process is performed
Yard	A system of tracks, other than mainline running lines and sidings, used for making and breaking up trains, loading and unloading of trains and for other purposes, such as repair or storage of rolling stock

7. Appendices

7.1. Critical Turnout Diagrams

Figure 7-1 Definition of Switch and Crossing Areas



7.2. Ineffective Fastening Examples

Figure 7-2 Effective Fastenings

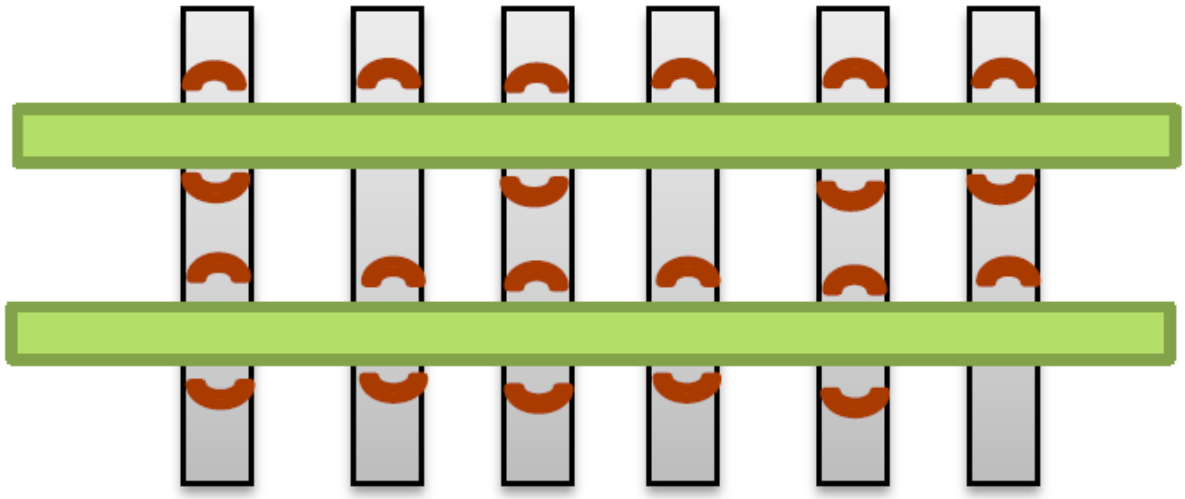


Figure 7-2 shows missing clips (3) or biscuits, but not consecutive on a single rail, and is therefore deemed effective as per Section 4.4.2.1.

Figure 7-3 Effective Fastenings

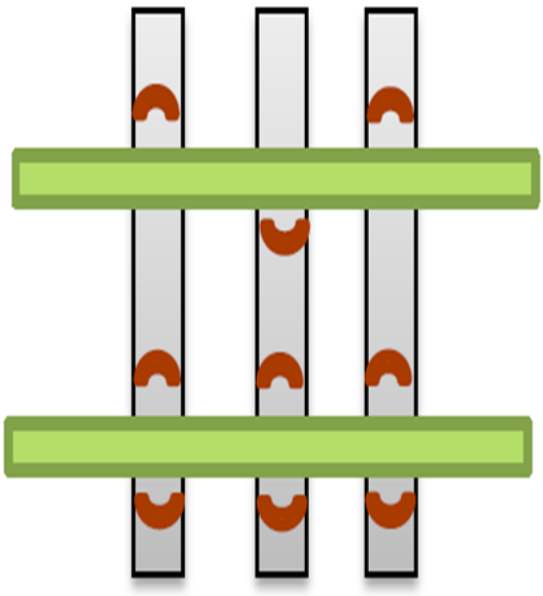


Figure 7-3 shows missing clips (3) on consecutive sleepers over a single rail but less than 6 units over sleepers and is therefore deemed effective as per Section 4.4.2.1.

Figure 7-4 Ineffective Fastenings

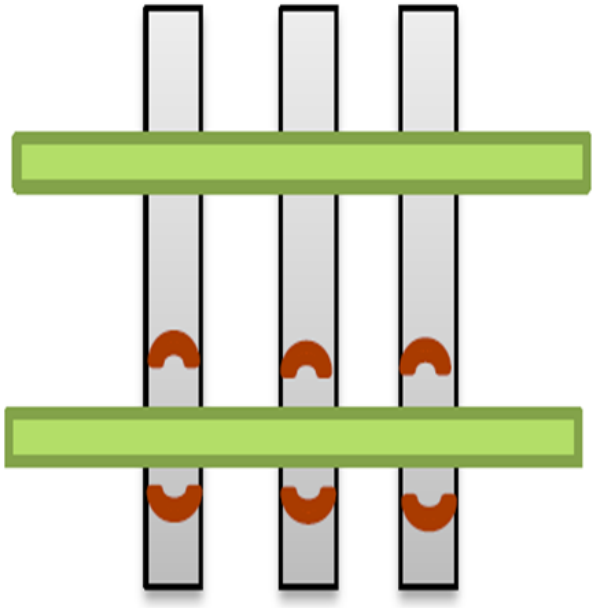


Figure 7-4 shows missing clips (6) on single rail and all fastenings present in the opposite rail, and is therefore deemed ineffective as per Section 4.4.2.1.

7.3. Skewed Sleeper Examples

Figure 7-5 Effective Sleeper Skewing

Figure 7-5 shows skewed sleepers with full fastenings on both rails and greater than 100 mm spacing at both ends, and is therefore deemed effective as per Section 4.4.2.2.

Figure 7-6 Ineffective Sleeper Skewing

Figure 7-6 shows skewed sleepers with full fastenings, but less than 100 mm spacing at one end, and is therefore deemed ineffective as per Section 4.4.2.2.

Figure 7-7 Skewed Sleeper Adjacent to a Weld

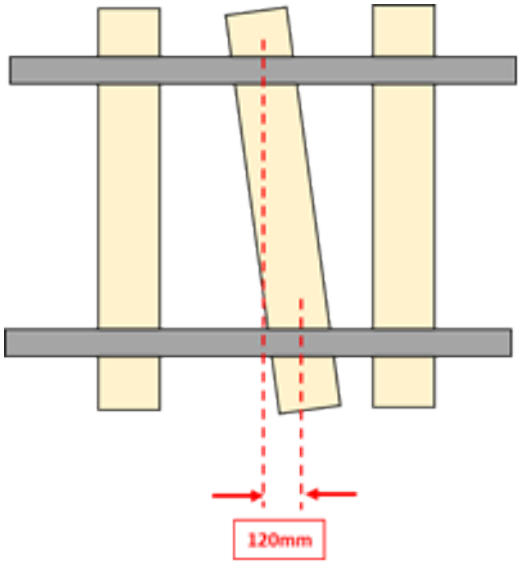


Figure 7-7 shows the maximum skewing distance of a sleeper or bearer when it is located within two cribs either side of a weld.