bhpbilliton

Iron Ore Controlled Document

**Standard**

# Track Maintenance Code of Practice

Rail Engineering Number: 0002664 Version: 5.0



## Electronic Approval Record

| Author Role | Name | Date of Change |
|---|---|---|
| | Mathew Kenworthy | 04/16 |
| **Reviewer Role** | **Name** | **Date of Change** |
| Track Reliability Specialist | Ben Fenton | 04/16 |
| **Approver Role** | **Name** | **Date of Change** |
| Acting Manager Rail Engineering | Glenn Osborne | 04/16 |

## Key Stakeholders

The following people and roles have a stated interest in this document and should be informed of any significant changes to content:

| Department | Name | Position |
|---|---|---|
| Track & Signals | Michael Rose | Manager Track & Signals |
| Track & Signals | Adrian Balasso | Acting Superintendent Track and Signals Analysis and Improvement |
| Track & Signals | Luke Bolzan | Superintendent Track Maintenance |
| Track & Signals | Nick Tegousis | Superintendent Track Maintenance |
| Track & Signals | Jonas Lindberg | Superintendent Major Works |
| Rail Engineering | Glenn Osborne | Acting Manager Rail Engineering |
| Rail Engineering | Darryl Jones | Superintendent Engineering Technical Support |
| Rail Engineering | Ben Fenton | Track Reliability Specialist |

## Document Amendment and Approval Record

| Version | Date | Description of Changes | Revised By & Position | Reviewed By & Position | Approved By & Position |
|---|---|---|---|---|---|
| 1.0 | 10/10/11 | New Document | Michael Sheridan Senior Track Engineer | Michael Sheridan Senior Track Engineer | Bobby Tang Superintendent Track Engineering |
| 2.0 | 24/05/13 | GRAA audit action 'TFAADQL1212005985' | | | |
| 2.1 | 29/07/13 | Table 3.3 – typographical corrections;<br>Table 12.4 – revision to wide gauge & tight gauge thresholds for Category 2 and 3 Track. | Ed Crisp Senior Track Engineer | Ed Crisp Senior Track Engineer | Bobby Tang Superintendent Track Engineering |
| 3.0 | 28/01/16 | Retired version published in error | N/A | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| 4.0 | 30/01/16 | New Document Structure<br>Change of content as per MOC 412898297 | Ben Fenton<br>Track Reliability Specialist | Joe Gero<br>Engineering Technical Support | Murray Lynch<br>Acting Manager Rail Engineering |
| 5.0 | 20/04/16 | Format and minor content revisions following review by Track Maintenance representatives. | Mathew Kenworthy | Ben Fenton<br>Track Reliability Specialist | Glenn Osborne<br>Acting Manager Rail Engineering |

## Page Intentionally Left Blank

# Contents

# Tables

# Figures

# 1. FOREWORD

## 1.1. DOCUMENT SCOPE AND PURPOSE

The purpose of this code of practice is to set out the Standards and Requirements to ensure the efficient operation and maintenance of the BHPBIO 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 BHPBIO 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 what triggers

The document use process is as follows:

1. Understand the asset,
2. Carry out the required inspection,
3. Identify defects and apply immediate responses,
4. Carry out maintenance.

This code of practice recognises that the BHPBIO 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 document's purpose is to support efficient and economical operation of the BHPBIO 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.

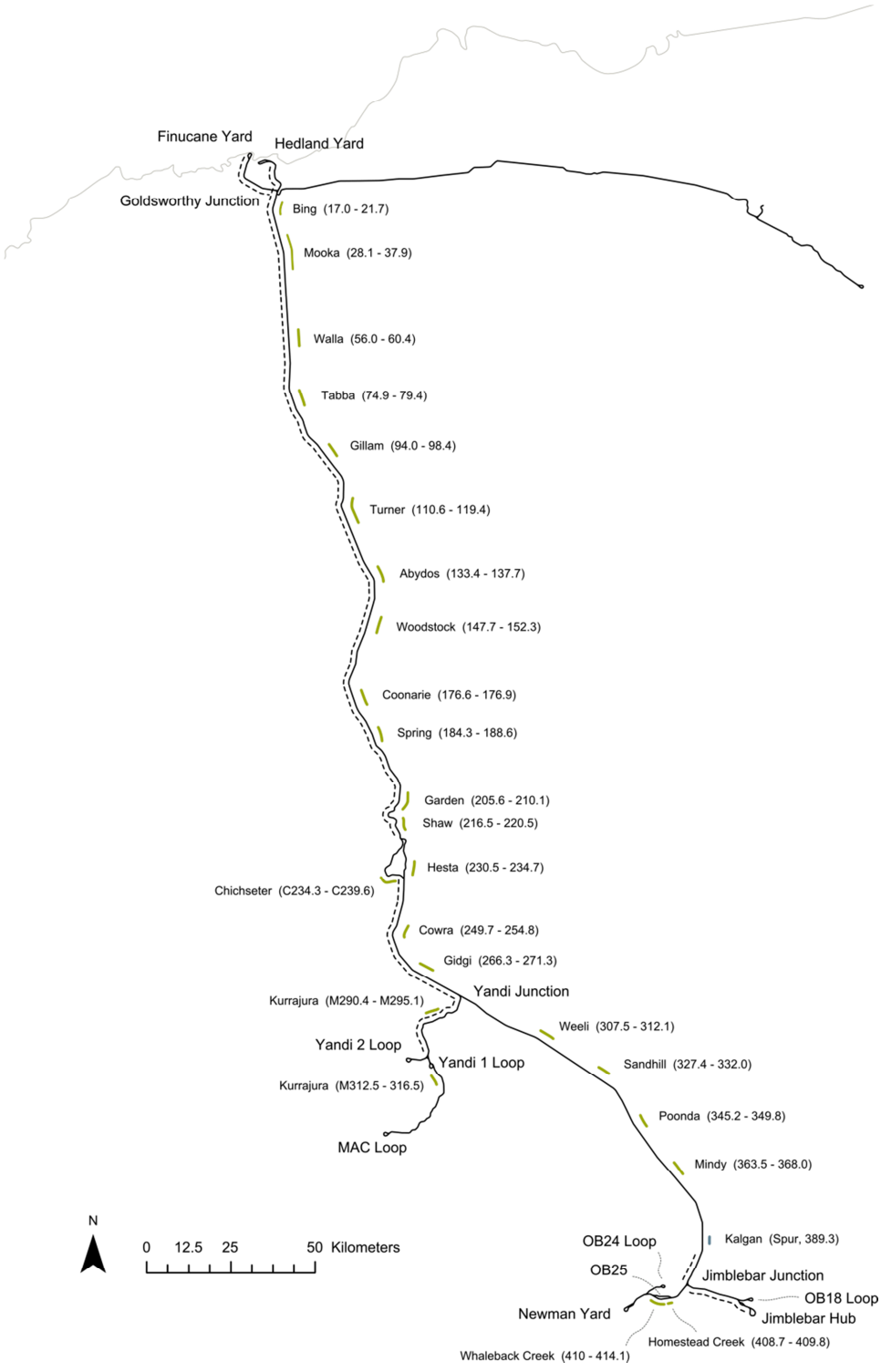
Content relating to the safe operation and maintenance of the BHPBIO Railroad is also contained in the Railroad Rule Book. In addition to the Railroad Rule Book, this code of practice provides upper or lower limit thresholds with corresponding response codes for the purpose of safety and/or protecting 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 375 Million Gross Tonnes Per Annum (equivalent to railing 276 Million tonnes of ore).

## 1.2. THE BHPBIO RAILROAD

FIGURE 1-1 BHPBIO RAILROAD MAP

This code of practice applies to the BHPBIO Railroad shown in the following map:



The BHPBIO 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 | CATEGORY 1A | CATEGORY 1 | CATEGORY 2 | CATEGORY 3 |
|---|---|---|---|---|
| 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 | | | |

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 is the East Rail (ER) and the rail on the right is the West Rail (WR).

## 1.3. DOCUMENT APPLICATION

This code of practice is only for use by authorised staff and contractors of BHPBIO in relation to the Railroad operations of the Company in the Pilbara.

This code of practice shall be kept confidential by such users and also by anybody to whom it is submitted for accreditation purposes and no information relating to this document shall be divulged to any person at any time, except with prior consent of BHPBIO.

## 1.4. 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.

Revisions of this code of practice will be published every three 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.

Any technical changes will be subject to risk assessment and the BHPBIO Management of Change process, if required. 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 Rail Engineering Superintendent.

Some changes that adversely affect risk and safety of the BHPBIO Railroad may need to be communicated to the rail safety regulator. The Safe Working department should be consulted whenever a safety or risk related change is proposed.

This code of practice should be managed and controlled in compliance with the BHPBIO 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.

Sections of this code of practice can be suspended by including ‘Under Review’ in the section title. Sections that are Under Review may not be active, in which case consideration should be given to other mitigating actions to ensure that users of this code of practice have sufficient information to continue to safely carry out their duties. Users of sections that are Under Review should be aware that changes to the section are likely to occur.

Similarly, new sections that were not previously covered in this code of practice shall be indicated by including ‘Opportunity’ in the section title. Sections identified with Opportunity are not active however users of this code of practice should be aware that these sections are likely to become active.

## 1.5. 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 Senior Track Engineer.

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 Senior Track Engineer of the details as soon as practicable.

## 1.6. 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 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 Track and Signals Superintendent(s) and Manager 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 Track and Signals department and relevant delegates until completion.

## 1.7. DOCUMENT INTERPRETATION

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

## 1.8. OVERRIDING CIRCUMSTANCES

Although adherence to this code of practice is a requirement, innovation and continual improvement is always supported. On occasions the Senior Track Engineer may deem that, due to other contributing factors, it would be reasonable and beneficial to BHPBIO to work outside of the requirements of this code of practice. Overriding the requirements of this code of practice can only be approved by the Senior Track Engineer and shall be documented in writing. Safety, however, shall never be compromised.

If the approved non-compliance is short term and related only to a specific situation then this shall be clearly and explicitly documented within the 1SAP system (see below) including date and time of the non-compliance, contributing factors, external considerations and decisions.

If the non-compliance is widespread and applicable as an ongoing requirement and/or applicable to different situations then the BHPBIO Management of Change process and document update process shall be initiated and any permanent decisions and changes shall be documented.

## 1.9. WORK MANAGEMENT AND USE OF 1SAP

The approved Computer Maintenance Management System (CMMS) for the BHPBIO Railroad is 1SAP. 1SAP shall be used to manage the preventative and corrective maintenance of the BHPBIO 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.

# 1.10. REFERENCE DOCUMENTS

## 1.10.1. 1DOC

The following documents can be found in 1DOC.

| | |
|---|---|
| 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 |

## 1.10.2. Controlled Documents

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

| | |
|---|---|
| CD - 0118073 | Train Control Asset Protection Systems |
| CD - 0119118 | Rail Rule Book M05 Signal, Boards & Signs |
| CD - 0119120 | Rail Rule Book M07 Service & Work Trains |
| CD - 121599 | WAIO Extreme Weather Procedure |
| SPR-HIS-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 |
| WIN - 0076704 | Work Instruction - 1Y Mech Svce Bridge Transom |
| WIN - 0076705 | Work Instruction - 1Y Mech Svce 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 & Svce Turnout SNX |
| WIN - 0087640 | Work Instruction - Repl Turnout Closure Rail |
| WIN - 0087641 | Work Instruction - Grind & Svce Turnout RBM |
| WIN - 0087643 | Work Instruction - Repl Turnout Insulated Rail Joint (Glued) |
| WIN - 0087648 | Work Instruction - Tamp Turnout Bearers (Manual) |
| WIN - 0087649 | Work Instruction - Lube & Svce Turnout SNX |
| WIN - 0087651 | Work Instruction - Repl Turnout Rollers |
| WIN - 0087652 | Work Instruction - Repl Turnout Spreader Bar |
| WIN - 0087653 | Work Instruction - Lube & Svce Turnout RBM |
| WIN - 0087655 | Work Instruction - Adj Turnout Bearer |
| WIN - 0087657 | Work Instruction - Svce Turnout per Way Welding RBM |
| WIN - 0087658 | Work Instruction - Svce Turnout per Way Welding SNX |
| WIN - 0096245 | Work Instruction - Repl 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 |
| WIN - 0106584 | Work Instruction - Remove / Replace Handrails - DeGrey Bridge |
| WIN - 0106585 | Work Instruction - Access Road Sign Installation |
| 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 - 106581 | Work Instructions - Inspecting Access Roads |
| WIN - 106585 | Work Instructions - Access Road Sign Installation |
| WIN-RTS-RTM-100 | Work Instruction - Hand Tamping (Hydraulic, Pneumatic & Petrol) |

| | |
|---|---|
| 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 and Installation of Mini-plug |
| WIN-RTS-RTM-090 | Work Instruction - Gemco Re-Sleepering Machine (Operation of) |
| WIN-RTS-RTM-091 | Work Instruction - Glued Joints (Making of) |
| WIN-RTS-RTM-092 | Work Instruction - Repl 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 - Repl 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 - Repl Turnout Stock Rail & Switch Blade |
| WIN-RTS-RTM-124 | Work Instruction - Repl 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-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 |

### 1.10.3. ProjectWise

The following documents can be found on ProjectWise.

| | |
|---|---|
| 073-C-00647 | No. 20 R910 Turnout Swing Nose Crossing - Fanned Concrete Sleepers 68kg Rail |
| 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-M-00067 | Railway Rolling Stock - Line Clearance Diagrams |
| 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-00026 | Turnout Construction and Maintenance Pad – 1 in 10 Turnouts |
| 000-R-00027 | Turnout Construction and Maintenance Pad – 1 in 15 Turnouts |
| 000-R-00028 | Turnout Construction and Maintenance Pad – 1 in 20 Turnouts |
| 000-R-00029 | Typical IRJ Placement - 1 in 10, 1 in 15 and 1 in 20 Turnouts |
| 000-R-00030 | Typical IRJ Placement - 1 in 10, 1 in 15 and 1 in 20 Crossovers |
| 067-M-02279 | Train Load out - Pandrol Rail Clip Type e2043 |
| 073-C-00461 | Concrete Sleeper Manufacturing Plant - Prestressed Concrete Sleepers Details |
| 073-C-00580 | No. 10 Turnout RH 68kg - Fanned Concrete Sleepers |
| 073-C-12009 | No. 15 Turnout RH Swing Nose Crossing - Fanned Concrete Sleepers 68kg Rail |
| 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 |
| FUSP-000-E-00004 | Functional Specification - Signalling |
| SPEC-000-C-00117 | Specification - Tracklaying Construction Requirements |
| SPEC-000-C-12001 | Specification - Ballast Manufacture and Supply |
| SPEC-000-C-12002 | Specification - Flashbutt Welding Of Rails |
| 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-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-000-S-00067 | Specification - Aluminothermic Welding of Rails |
| SPEC-006-E-12122 | Specification - Level Crossing Design and Construction |
| SPEC-073-C-12000 | Specification - Non-Destructive Testing Ultrasonic Testing –General Requirements |
| SPEC-073-C-12001 | Specification - Non-Destructive Testing of In Track Rail & Rail Welds via Rail Flaw Detection Vehicle |
| SPEC-073-C-12002 | Specification - Non-Destructive Testing Ultrasonic Testing –Hand Testing of Rail Welds and Rail |
| SPEC-073-C-12003 | Specification - Non-Destructive Testing Magnetic Particle Testing – General Requirements |
| SPEC-073-C-12004 | Specification - Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast |
| SPEC-073-C-12005 | Specification - Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast- Rail Flashbutt Welds |
| SPEC-073-C-12006 | Specification - Rail Defects – Classification of Defects and Assessment of Defect Severity |
| SPEC-073-C-12007 | Specification - Defects – Classification of Rail Surface Condition Associated with Rolling Contact Fatigue Damage |
| SPEC-077-M-00002 | Specification - Rail Grinding Machine |
| TMAN-073-C-12000 | Technical Manuals and/or Design Manuals - 1 in 20 Swing Nose Crossings Turnouts & Crossovers |
| TMAN-073-C-12001 | Technical Manuals and/or Design Manuals - 1 in 10 Swing Nose Crossings Turnouts & Crossovers |
| TMAN-073-C-12002 | Technical Manuals and/or Design Manuals - 1 in 15 Swing Nose Crossings Turnouts & Crossovers |

## 1.10.4. Standards

The following documents are Australian Standards and can be found on Standards On-Line.

| | |
|---|---|
| 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 - Fishbolts 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 – 2009 | 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 |

| | |
|---|---|
| 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 |
| 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 |

# 2. ASSETS

# 2.1. TRACK

## 2.1.1. Types and Use

The New, Removed and Modified Asset Master Data Procedure shall be adhered to whenever a track asset is installed, removed or modified on any part of the BHPBIO Railroad.

Newly constructed track shall be designed and constructed in accordance with the relevant specifications listed in Section 2.1.2. Reconstruction of track as part of a maintenance function shall be carried out in accordance with the relevant sections of this document.

Maintenance of track shall be performed using material defined through Section 2 to tolerances as defined in Section 4. If maintenance takes place whilst trains are in operation and where track 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 should be 20 km/h, all movements should 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 measured using the mid-ordinate offset of a 10 metre chord at any location should not exceed 40 mm.

## 2.1.2. Reference Documents

| | |
|---|---|
| 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) |
| TBC | New, Removed and Modified Asset Master Data Procedure |

## 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.

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;
- 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 BHPBIO Management of Change Process and be carried out in accordance with the appropriate BHPBIO Disposal policies. Consideration should be given to:

- Health,
- Safety,
- Environment,
- 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) painted with red paint;
- 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 BHPBIO 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 Senior Track Engineer.

For details including, but not limited to, manufacturing and quality requirements, mechanical and 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 BHPBIO 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 BHPBIO Railroad.

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 | GRADE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Nippon Steel Corporation (NSC) | HE400 | ✓ | ✓ | ✓ |
| | HEX | Only with prior approval from the Senior Track Engineer | | |
| OneSteel | Head Hardened (HH) | × | × | ✓ |
| Voestalpine Schienen (VAE) | UHC400 | Only with prior approval from the Senior Track Engineer | | |
| Pangang | PG4HT | Only with prior approval from the Senior Track Engineer | | |

The rail types shown in the table above are identifiable by marks on the web of the rail. Examples of these marks are shown in the following images. The unique rail grade identifier is highlighted.

FIGURE 2-1 RAIL IDENTIFICATION MARKINGS

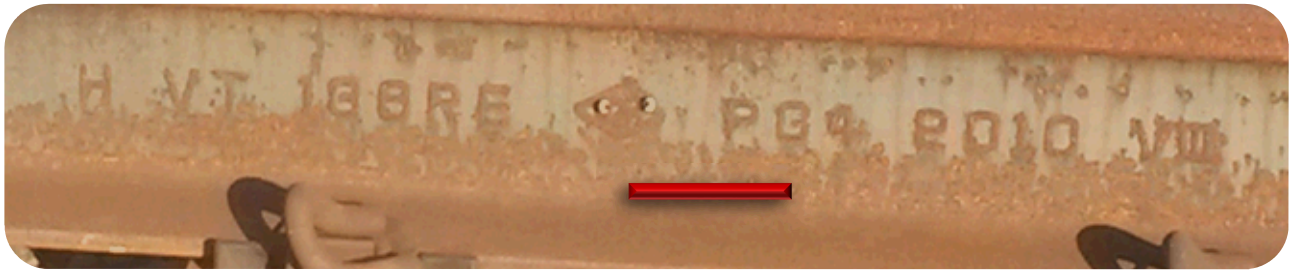
Nippon HE400, Unique Identifier Stamp: HE400

Nippon HEX, Unique Identifier Stamp: 141 AB


Onesteel HH, Unique Identifier Stamp: ONE

Voestalpine UHC400, Unique Identifier Stamp: UHC

Pangang PG4HT, Unique Identifier Stamp: PG4




### 2.2.1.3. Rail Head Profile

New 68 kg/m rail should be supplied with the specific BHPBIO rolled rail head profile, as detailed in SPE-000-C-12007. The BHPBIO 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 Neutral Temperature

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.

TABLE 2-2 DESIGN NEUTRAL TEMPERATURE (STRESS FREE)

| MINIMUM | MAXIMUM |
|---|---|
| 37°C | 42°C |

### 2.2.1.6. Closure Rails

Closure Rails shall conform to the following criteria in addition to other requirements in Section 2.2.4:

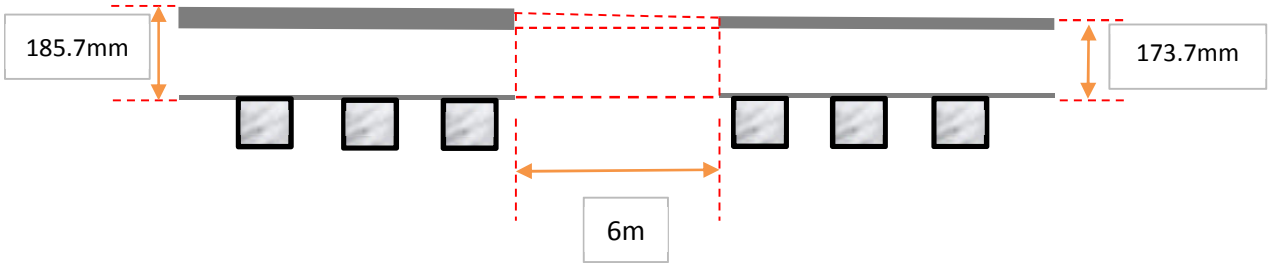
- the head profile shall be compatible with the rail head profile of the rail to be removed such that rail misalignments are not introduced into track,
- there shall be a maximum rail height difference of 8mm (with the use of step welds). If this tolerance cannot be met a transition rail is to be used,
- closure rails shall have a minimum length of 6m on tangents and 9m on curves.

### 2.2.1.7. Transition Rails

Transition rails are to be used to join rail of different heights and are mandatory when the rail height difference exceeds 8mm. Transition Rails shall conform to the following criteria:

- rail head height should be machined from new rail (185.7 mm) at a rate not steeper than 12 mm over a 6m length as shown in Figure 2-2,
- rail head profile shall be maintained,
- transition rails shall be installed on both rails,
- transition rails shall be installed directly opposite each other. Staggering of transition rails is not permitted.

FIGURE 2-2 DESIGN TAPER OF TRANSITION RAIL




### 2.2.1.8. Rail Lubrication and Friction Modifying Agents (Opportunity)

Rail lubrication is currently only in use at Car Dumper 3 in Hedland Yard. There is currently no provision for installation of further rail lubrication devices on the BHPBIO Railroad network.

### 2.2.2. Reference Documents

| | |
|---|---|
| DESC-000-C-00001 | Design Criteria Track Design |
| SPEC-000-C-00117 | WAIO Standards – Rail Track Work – Tracklaying Construction Requirements |
| SPEC-000-C-12002 | Flashbutt Welding Of Rail |
| SPEC-000-C-12007 | Heavy Haul Rails |
| SPEC-000-S-00067 | 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 and Installation of Mini-plug |

### 2.2.3. Handling and Storage

To ensure that potential damage caused by transportation, handling and installation of rail is minimised, the procedures listed above 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.

### 2.2.4. Reuse and Disposal

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

- presence of internal and surface rail defects, by visual and ultrasonic means of inspection;
- presence of top and side wear.

Other than for use as part worn closure rails, rail shall not be re-used in catergory1 track.

Transposing of rails is not recommended.

Ultrasonic testing of the entire rail length to be reused shall be undertaken prior to being returned to track.

In addition the following should be considered to assess the suitability of rail reuse:

- presence of welds;
- rail cross section;
- gauge face angle;
- rail end straightness;
- rail twist;
- metallurgical properties.

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;
- 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.

## 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 AS 1085.14 and SPEC-000-R-00001. Commissioning of new sleepers onto the BHPBIO Railroad shall be accompanied by appropriate testing documentation and certification. Sleeper design shall facilitate:

- 1435mm gauge;
- 68kg/m rail;
- 1:30 rail cant;
- Sleeper spacing at 600mm;
- Resilient fastenings;
- 50 tonne nominal axel load;
- 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 switch and crossing structures 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 rail,
- Allowance for forces and movements induced from switch motors and other such equipment.

Hollow steel sleepers may be used if designed, constructed and installed in line with relevant specifications and with approval from the Senior Track Engineer.

Sleepers shall be installed perpendicular to the centreline of the track with spacing as defined by Table 2-4 ±10 mm. Skewing shall be limited to ±10mm measured at the sleeper ends.

Concrete sleepers shall be used for Category 1 and 2 tracks when carrying out sleeper replacement; however timber and steel sleepers are in use in localised areas on Category 2 and 3 track. Allowable use of different sleeper types is shown in Table 2-3 below.

TABLE 2-3 ALLOWABLE SLEEPER TYPES

| TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Timber Sleepers | x | ✓ | ✓ |
| Concrete Sleepers | ✓ | ✓ | ✓ |
| Steel Sleepers | x | ✓ | ✓ |
| Hollow Steel Sleepers | Only with prior approval from Senior Track Engineer | | |

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

TABLE 2-4 SLEEPER DIMENSIONS

| TYPE | LENGTH | WIDTH | HEIGHT | SPACING |
|---|---|---|---|---|
| Timber Sleepers | 2600mm minimum | 225mm minimum | 150mm minimum | 533mm nominal |
| Timber Bearers | 2600mm minimum | 300mm minimum | 175mm minimum | 533mm nominal |
| Prestressed concrete sleepers | 2550mm minimum | 240mm minimum | 240mm minimum | 600mm nominal |
| Prestressed concrete bearers | 2600mm minimum | 248mm minimum | 248mm minimum | 600mm nominal |
| Steel Sleepers (Trak-Lok 2) | 2590mm | 300mm | 118mm | 600mm nominal |

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.

## 2.3.2. Reference Documents

| | |
|---|---|
| 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-461 | Prestressed concrete sleepers 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 |
| 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) |

### 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
- Disposal

Sleepers that have the potential for reuse shall be marked in such a manner that the reuse potential is clear and unambiguous. In addition the design and 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;
- 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.

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

# 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 BHPBIO 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.

Creep resistant Pandrol Hytrel type pads are currently being trialled on steep grade areas and areas susceptible to skewing of sleepers.

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

Note that 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 on 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 be used on Category 3 track however resilient fastenings are preferable.

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);
- 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

| | |
|---|---|
| 067-M-02279 | Pandrol Rail Clip Type e2043 |
| 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) |

### 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 (Under Review)

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

- Reusable
- Quarantine
- Disposal

Inspection of fastening toe loads may be undertaken for the purposes of assessing the suitability of fastenings for re-use. The inspection should comprise of a visual inspection of clip condition along with testing of the toe load applied to the rail foot from the clip. Use of a go/no-go gauge is recommended to simply determine the approximate toe load being applied by the clip.

Fastenings that are suitable for reuse based upon visual condition assessment and toe load testing results shall be marked in such a manner that the reuse potential is clear and unambiguous. Fastening type (if required) and number of units should also be included in these markings.

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

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

- pads;
- insulators;
- 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;
- 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/$m^2$ 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.

### 2.5.1.1. Ballast Profile

A typical track cross-section illustrating ballast profile is shown in Figure 2-3.

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

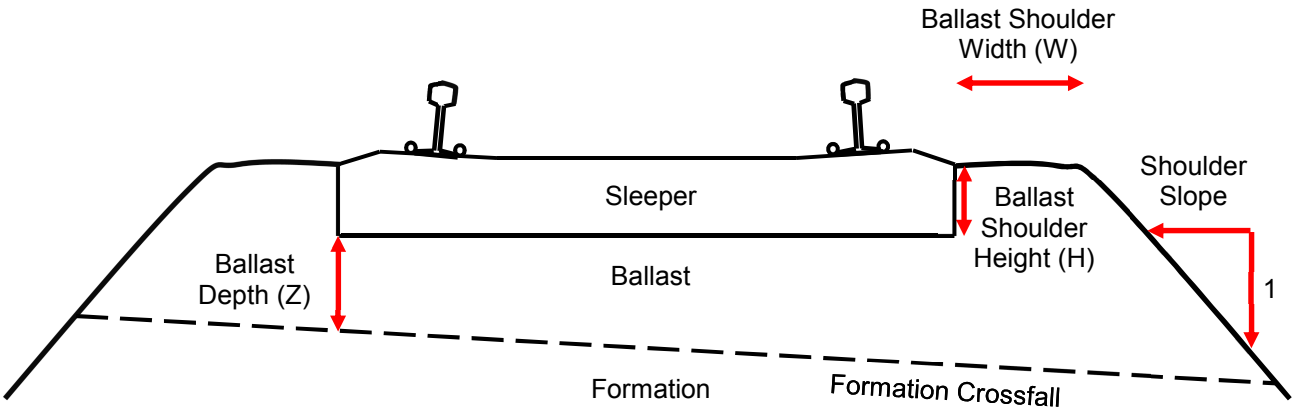
Ballast depth (Z) is measured under the rail seat (of the low rail on curves) from the base of the sleeper to the bottom of the ballast layer and does not include sub ballast where used. Sufficient ballast depths are critical to minimise and evenly distribute rolling stock loads on the formation. Ballast depths in excess of those shown in Table 2-5 decrease the stability of the track and if not managed appropriately may result in uncontrolled settlement and cause early degradation of track geometry. Ballast depths in excess of those shown in Table 2-5 require additional engineering controls and approval from the Senior Track Engineer.

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 end of the level ballast shoulder, to the start point of the shoulder slope.

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 2-3 TYPICAL TRACK CROSS-SECTION AND BALLAST PROFILE




Nominal ballast profile dimensions for track on the BHPBIO Railroad are given in Table 2-5 for different track types and categories.

TABLE 2-5 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<br>Curves ≥ 900m Radius<br>Turnouts ≥ 1:20 | 320mm | 200mm | 200mm |
| | Curves < 900m Radius<br>Turnouts < 1:20 | 320mm | 200mm | 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 |
| Minimum Shoulder Width (W) From Sleeper End | Tangents<br>Curves ≥ 900m Radius<br>Turnouts ≥ 1:20 | 300mm | 300mm | 300mm |
| | Curves < 900m Radius<br>Turnouts < 1:20 | 550mm | 300mm | 300mm |

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 bogholes. When >30% of the material is smaller than 13.5mm 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. When laying new ballast, ballast depth should not exceed the limits described in Table 2-5 where practicable. Where this is not possible, additional engineering controls may be required to alleviate the risk of excessive track settlement. Engineering assessment is required in these situations and the method of control shall be approved by the Senior Track Engineer. These controls include:

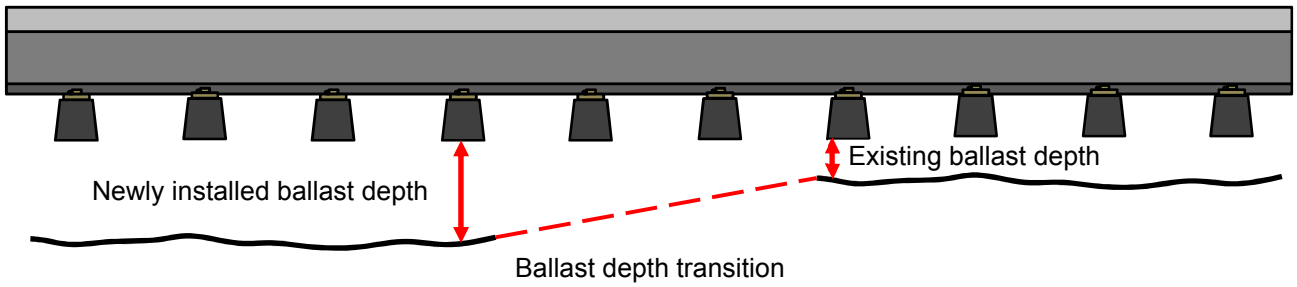
- installation of ‘Geogrid’ into ballast layers;
- installation of ‘Geoweb’ into ballast layers;
- increased tamping and maintenance regimes;
- use of road base instead of ballast in lower layers;
- increased compaction during construction.

### 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 2-4 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

| | |
|---|---|
| SPEC-000-C-12001 | WAIO Standards – Rail Trackwork - Ballast Manufacture and Supply |
| WIN-RTS-RTM-134 | WIN - Ballast Dropping (Main Line) |
| WIN - 102286 | WIN - Ballast Dropping (Remote) |
| WIN - 112355 | WIN - Ballast Pan Hungry Board Replacement |
| WIN - 118434 | WIN - Ballast Remediation (Boghole) |
| WIN-RTS-RTM-135 | WIN - Ballast Train Plough (Operation of) |
| WIN - 87638 | WIN - Box Turnout Ballast (Manual) |
| WIN - 99690 | 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 BHPBIO Railroad then new ballast shall be stored in ballast wagons towards each end of the BHPBIO 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.

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 BHPBIO 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 BHPBIO Railroad:

- Swing Nose Crossing (SNX) (1:10 / 1:15 / 1:20);
- Monoblock Crossing (1:10 / 1:15);
- 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 BHPBIO Railroad due to difficulties in lifting common bearers during maintenance works.

Table 2-6 details the switch and crossing assemblies that are allowed for use on the BHPBIO 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 2-6 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 | × | ✓ | ✓ |
| | 1:15 Standard (R320m) | 35 km/h | ✓ | ✓ | ✓ |
| | 1:15 Tangential (R500m) | 45 km/h | ✓ | ✓ | ✓ |
| | 1:20 Standard (R910m) | 60 km/h | ✓ | ✓ | ✓ |
| | 1:20 Tangential (R1000m) | 65 km/h | ✓ | ✓ | ✓ |
| Monoblock Crossing | 1:10 Standard (R221.026) | 25 km/h | × | ✓ | ✓ |
| Rail Bound Manganese Crossing (RBM) | 1:10 Standard (R221.026) | 25 km/h | × | ✓ | ✓ |
| | 1:15 Standard (R320m) | 35 km/h | × | ✓ | ✓ |

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.

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

| | |
|---|---|
| AS 1085.21 | Turnouts, Switches and Crossings |
| TMAN-073-C-12001 | 1:10 Swing Nose Crossings |
| 073-C-00580/1<br>073-C-00580/2 | 1:10 LH and RH Turnout 68kg Rail Layout Drawings |
| TMAN-073-C-12002 | 1:15 Swing Nose Crossings |
| 073-C-12009 | 1:15 Turnout 68kg Rail SNX Layout Drawing |
| TMAN-073-C-12000 | 1:20 Swing Nose Crossings |
| 073-C-00647 | 1:20 R910m Turnout 68kg Rail SNX Layout Drawing |
| TMAN -073-C-12255 | RBM Crossings |
| 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-00026 | Trackwork – Turnout Construction and Maintenance Pad – 1 in 10 Turnout |
| 000-R-00027 | Trackwork – Turnout Construction and Maintenance Pad – 1 in 15 Turnout |
| 000-R-00028 | Trackwork – Turnout Construction and Maintenance Pad – 1 in 20 Turnout |
| 000-R-00030 | Trackwork – Typical IRJ Placement 1in10, 1in15 and 1in20 Crossover |
| 000-R-00029 | Trackwork – Typical IRJ Placement 1in10, 1in15 and 1in20 Turnouts |
| 000-R-00024 | Trackwork – Zero and 1:60 Cant Reducing Bearer Mainline Turnout Installation |
| 000-R-00025 | Trackwork –1:60 Cant Reducing Bearer Yard Turnout Installation |
| 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-178 | Turnout - Stock Rail Replacement (Yard) |

| | |
|---|---|
| WIN-RTS-RTM-125 | Switches (Servicing of) |
| WIN - 0087639 | Grind & Service Turnout SNX |
| WIN - 0087649 | Lube & Service Turnout SNX |
| WIN - 0087641 | Grind & Service Turnout RBM |
| WIN - 0087653 | Lube & Service Turnout RBM |
| WIN - 0087640 | Replace Turnout Closure Rail |
| WIN-RTS-RTM-190 | Switch Grinding |
| WIN-RTS-RTM-189 | Remove/Replace Plates |
| WIN - 0087648 | Tamp Turnout Bearers (Manual) |
| WIN - 0087650 | Replace Turnout Heel Blocks |
| WIN - 0087651 | Replace Turnout Rollers |
| WIN - 0087652 | Replace Turnout Spreader Bar |
| WIN - 0087655 | Adjust Turnout Bearer |

### 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.

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 BHPBIO 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,
- 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.

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 6 hole joint bars. Only Nippon (NSC) grade HE400 insulated rail joints are approved for installation into the BHPBIO Railroad. Use of any other rail type requires the approval of the Senior Track Engineer.

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

Every time an insulated rail joint is replaced in track an 'Insulated Joint Installation' form shall be completed and sent to Track and Signals Analysis & Improvement team within seven (7) days. The installation date of the insulated rail joint shall be written beside the plate on the field side in white paint pen.

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.

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 within 15m of the switch toes.

## 2.7.2. Reference Documents

| | |
|---|---|
| AS 1085.12 | Insulated Joint Assemblies |
| SPEC-000-C-12005 | Design, Manufacture and Supply of Turnouts, Catchpoints and Insulated Rail joints |
| SPEC-000-C-12002 | Flashbutt Welding of Rails |
| FUSP-000-E-00004 | WAIO Standard Signalling Design Principles |
| WIN-RTS-RTM-091 | Glued Joints (Making of) |
| 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. Each insulated rail joint shall be supported in five (5) evenly spaced locations using timber gluts.

### 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 fishplated joints covered in AS 1085.2, or be equal to or exceed the performance of current proven designs. The standards shown in Section 1.10.4 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 Joint

The use of non-insulated rail joints as permanent rail joints on plain line track is only allowable in Track Category 3 locations such as Yards.

In crossings, turnouts and other locations where fixed joints are used, the use of swage lock fastenings in lieu of bolts is a 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:

- 6 hole/6 bolt fishplated joints;
- each pair of rail joints shall be installed in the same sleeper crib, i.e. square, not staggered;
- joints shall be centrally suspended between sleepers.

Fishplated rail joint components shall be manufactured to conform to the appropriate Australian Standards referenced in Section 1.10.4.

### 2.8.1.2. Temporary Rail joints

Temporary rail joints may be formed with clamped fishplates provided that a minimum of three (3) G clamps are used with each fishplate set. Temporary joints formed using fishplates and G 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 rail joints formed using Robel clamps in operational Category 1 track shall be replaced with permanent joints within 72 hours.

### 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 BHPBIO Railroad.

## 2.8.2. Reference Documents

| | |
|---|---|
| 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 Mini-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

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

- Flashbutt welding;
- Aluminothermic welding.

Flashbutt welds are the preferred type rail joint as aluminothermic welds are known to have a higher probability of failure under service conditions at BHPBIO.

### 2.9.1.1. Flashbutt Welds (Under Review)

Fixed flashbutt welding operations and (welding using fixed flashbutt welding plant) shall be in compliance with SPEC-000-C-12002 and in accordance with WIN-0109654.

Mobile flashbutt welds installed in the field shall be in compliance with SPEC-000-C-12002 and installed in accordance with WIN-0102849.

All welding procedures shall be qualified as per AS 1085.20.

The welder executing the weld shall be fully trained, competent and hold current certification and Verification of Competency (VOC) to weld on the BHPBIO 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. 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,
- Rail grade.

Corrective actions in the event of non-conformances may include:

- withdrawal of the welder certification,
- recalibration of welding equipment,
- retraining of welder.

When welding rails together, a maximum height difference of 5mm 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.

Weld quality shall be initially confirmed by the welder by means of visual observation of the welding process, review of the graph or meter 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 of the welding activity;
- reassessment of the process;
- rework including potential installation of a new 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.

All welds shall be internally non-destructively tested as per Section 3.11. Fixed flashbutt welds shall be tested upon production prior to being installed into track. Mobile flashbutt welds shall be tested within 14 days of installation.

#### 2.9.1.2. Aluminothermic Welds

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 SPEC-000-S-00067 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 BHPBIO 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 BHPBIO,
- Welders Assistant Theory/Practical.

Welders 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 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 and shall comply with the limit values specified in WIN-RTS-RTM-127. 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 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 of the welding activity;
- reassessment of the process;
- rework including potential installation of a new 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. 1510AA01

All welds shall be internally non-destructively tested as per Section 3.11.

#### 2.9.1.3. Welds on Bridges

All rail welds on or within 50m of a bridge should be of flashbutt type. Aluminothermic welds should only be used in an emergency or as a temporary repair, if a mobile flashbutt welder is not available.

In this instance, aluminothermic welds on or within 50 metres of a bridge are to be protected through plating using the drill and bolt method.

Aluminothermic welds on or within 50 metres of a bridge are to be plated and then clamped for a period of 24 hours to allow sufficient time for weld cooling. Once a weld has been in track for more than 24 hours, the weld must be drilled and bolted.

The aluminothermic weld shall be removed and replaced with a flashbutt weld within 28 days of installation.

### 2.9.2. Reference Documents

| | |
|---|---|
| AS 1085.20 | Welding of Steel Rail |
| WIN-RTS-RTM-127 | Aluminothermic Welding |
| SPR-HIS-SAF-034 | Hot Work Permit 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 |
| SPEC-000-S-00067 | Aluminothermic Welding of Rails |
| AS 3834 | Quality requirements for fusion welding of metallic materials |
| SPEC-000-C-12002 | Flashbutt Welding of Rails |

### 2.9.3. Handling and Storage

Weld material handling and storage to be defined.

### 2.9.4. Reuse and Disposal

Compromised materials shall be segregated from good condition materials and clearly marked for disposal to prevent them being put into track. Materials shall be appropriately disposed of as soon as is practicable.

# 2.10. LEVEL CROSSINGS

Level Crossings throughout the BHPBIO 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
    - Service level crossings are level crossings that provide access only for BHPBIO Railroad operations by authorised persons.

## 2.10.1. Types and Installation

Table 2-7 defines the approved types of level crossings for installation on the BHPBIO Railroad. Note that other level crossing types are currently in operation on the BHPBIO Railroad including:

- constructed from welded rail lengths;
- superseded concrete/steel design;
- superseded Humes crossing panel design;
- superseded steel design.

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

TABLE 2-7 APPROVED LEVEL CROSSING TYPES

| MANUFACTURER | MODEL | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Strail | NA | ✓ | ✓ | ✓ |
| JD | JD150 | ✓ | ✓ | ✓ |
| JD | JD250 | ✓ | ✓ | ✓ |

Note that 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.

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;
- 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;
- 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 Senior Engineer 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 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 fastenings, retighten if they are loose and replace any damaged or missing fastening hardware,
- check the accuracy of sleeper spacing as per manufacturers requirements,
- check track geometry is to the proper horizontal and vertical alignment,
- check there are no additional crossing obstructions (i.e. rail joints).

## 2.10.2. Reference Documents

| | |
|---|---|
| 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 |
| AGRD03/10 | Austroads publication – Guide to Road Design – Part 3: Geometric Design |
| 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) |

## 2.10.3. Handling and Storage

Level crossing components shall be handled, transported and installed in a manner so as 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 take into account 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, and
- eliminating as far as practicable any public or private hazard associated with decommissioned equipment, giving consideration to both short and long-term condition.

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,
- 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 BHPBIO Management of Change Procedure.

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 take into account the following documents where applicable:

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

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 BHPBIO 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,
- 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

| | |
|---|---|
| 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.

In the event that 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.

# 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.

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 BHPBIO Railroad shall adhere to the following:

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

## 2.12.2. Reference Documents

| | |
|---|---|
| DESC-000-C-00002 | WAIO Design Criteria Earthworks and Drainage |
| DESC-000-C-00001 | WAIO Design Criteria Track Design |
| WIN-RTS-RTM-183 | Front End Loader Operation |
| WIM - 0078027 | Excavator operation of |

## 2.12.3. 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.

## 2.12.4. 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.

# 2.13. ACCESS ROAD

## 2.13.1. Types and Installation

The BHPBIO 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/hr. 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 BHPBIO 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, hi-rail truck) to drive onto and off the track. Minimum width shall be 6m.

## 2.13.2. Reference Documents

| | |
|---|---|
| DESC-000-C-00002 | Design Criteria Earthworks and Drainage |
| WIN - 112356 | WIN - Repair Access Road Washout |
| 000-C-12012 | Roads – Typical Sections |
| 000-C-12013 | Road Furniture – Typical Details |
| 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 BHPBIO 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,
- 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;
- 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,
- 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

| | |
|---|---|
| AS 4292 | Railway Safety Management |
| AS 1742.7 | Manual of uniform traffic control devices |
| 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 - 0119118 | RRB M05 Signal, Boards and Signs |
| CD - 0106585 | Access Road Sign Installation |

## 2.14.3. Handling and Storage

Signs shall be handled, transported and stored in a manner so as 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
- Disposal

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

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 Rail Rule Book Module 7, CD – 0119120.

### 2.15.1. Reference Documents

| | |
|---|---|
| 076-M-01285 | Rolling Stock Handbook Index Page |
| 076-M-01286 | Loading Gauge and Structure Clearance Diagrams |
| 076-M-01287 | Loadout Tunnel Clearance Diagrams |
| 000-M-00067 | Railway Rolling Stock Line Clearance Diagram |
| DESC-000-C-00001 | Design Criteria Track Design |
| CD - 0119120 | Rail Rule Book M07 Service & Work Trains |

## 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,
- 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 Senior Track Engineer.

### 2.16.1. Reference Documents

| | |
|---|---|
| SPEC-000-C-00117 | WAIO Standards – Rail Track Work – Tracklaying Construction Requirements |

## 2.17. ASSET PROTECTION

Asset protection systems utilised on the BHPBIO Railroad include:

- Derailers,
- Catchpoints,
- Wheel and bearing monitors,
- Dragging equipment detectors,
- Rail temperature detectors,
- Weighbridges,
- Stream flow detectors,
- Level crossing warning and barricading systems,
- 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. Derailers (Opportunity)

Derailers are installed on the BHPBIO Railroad to protect assets and personnel from train roll away. Different types are installed including manually controlled and electrically operated types.

### 2.17.2. Guard Rails (Opportunity)

Guard rails are not mandatory however may be used on the BHPBIO 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,
- 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;
    - fastened to every sleeper.

### 2.17.3. Reference Documents

| | |
|---|---|
| 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 |
| CD - 0118073 | Train Control Asset Protection Systems |

# 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:

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 |
| bogholes 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 | |
| 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) | |
| TURNOUTS | |
| broken crossings, switch blades, or rails | wheel marks which indicate incorrect wheel/rail interaction |
| missing components | rail creep which may for example 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 |
| 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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Visual Patrol Track Inspection | 3 days | 4 days | 6 months |

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. In this scenario the inspections shall alternate from one track to the other each time the inspection is carried out.

e.g. for Category 1 track in a dual track section, both tracks shall be travelled on within a 1 week period.

### 3.1.3. Reference Documents

| | |
|---|---|
| WIN-RTS-RTM-096 | Hi Rail (Operation of) |

### 3.1.4. Inspector

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in identifying track defects;
- have knowledge of local factors;
- be knowledgeable regarding this code of practice.

### 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 require the use of 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,
- As part of a track handback 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, TCMV 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 in particular 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:

- radiographic testing,
- magnetic particle testing,
- dye penetrant testing,
- eddy current and magnetic induction.

## 3.2.2. 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

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in identifying track defects;
- have knowledge of local factors;
- be knowledgeable regarding this code of practice;
- 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 BHPBIO Railroad.

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 4.2.

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 Track and Signals Analysis and Improvement Superintendent 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;
- recorded data is processed and made available in a suitable database for analysis.

## 3.3.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Track Recording Vehicle Geometry Inspection | 6 weeks | 26 weeks | NA |
| Track Recording Vehicle Rail Profile Inspection | 12 weeks | 26 weeks | NA |
| Track Recording Vehicle Rail Wear Inspection | 12 weeks | 26 weeks | NA |

Note that without input from the Instrumented Ore Cars (IOC), maximum interval between TCMV geometry inspections for Category 1 tracks shall be decreased to 4 weeks.

If the inspection frequencies above for geometry inspections cannot be adhered to then an appropriate increase in visual track inspections shall be undertaken. These shall focus in detail on locations that had poor or deteriorating geometry at the last TCMV inspection and areas at risk of cyclic geometry development.

If the inspection frequencies above for rail profile cannot be adhered to then an appropriate increase in visual track inspections shall be undertaken. These shall focus in detail on high risk areas with tight curves and steep gradient to monitor for and report any rail profile defects.

If the inspection frequencies above for rail wear cannot be adhered to then other sources of rail wear data shall be sought and used. This may be 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 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

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 Engineer.

### 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,
- maximum period between stored data sets.

TABLE 3-2 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 | NA | NA |
| All Defect Types and Locations | NA | 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),
- 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;
- 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 for all speeds.

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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Instrumented Ore Car Inspection | 2 days | NA | NA |

## 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 HANDBACK AND QUALITY INSPECTION (UNDER REVIEW)

## 3.5.1. Inspection Purpose

Track work handback 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 Handback Inspection

Prior to the handback 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 handback should be followed.

### 3.5.1.2. 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, and to the Senior Track Engineer, 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;
- learnings from the task execution.

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

- photos of completed works,
- written feedback,
- 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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Track Work Handover Inspection | Prior to track handback | Prior to track handback | Prior to track handback |
| 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

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in track handback procedures (Handback Inspection);
- be competent in identifying track defects;
- have knowledge of local factors;
- be knowledgeable regarding this code of practice;
- be impartial from the execution of the completed maintenance works (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 handback 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,
- Gauge face angle,
- Unusual wear patterns and defects.

## 3.6.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Visual rail wear inspection | Validation or<br>As Required | Validation or<br>As Required | 12 months |

For curves < 900m radius on high trafficked 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 6mm 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. See the following example regarding calculating wear rate:

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 previous | = 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 3-3 VISUAL RAIL WEAR INSPECTION FREQUENCY WITHIN 6MM OF WEAR LIMITS

| WEAR DURING PERVIOUS 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

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in the use of rail wear measurement tools;
- be competent in identifying track defects;
- have knowledge of local factors;
- 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 3-3.

# 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. The minimum inspection frequency is five (5) MGT.

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,
- 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 us not possible.

The configuration of the ultrasonic testing system, including the number and configuration of the ultrasonic transducers, shall be determined on the basis of the defect types to be detected. Details of defect types which are known to occur in the BHPBIO Railroad are documented in SPEC-073-C-12006. As a basis the following standards should be used to derive the work instructions:

- AS 2083 for calibration of equipment,
- AS 1085.20 for weld test procedure.

The configuration of ultrasonic transducers and testing methodology is included in SPEC-073-C-12002.

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 be immediately reported to the Senior Track Engineer and recorded in the 1SAP system as a notification.

## 3.7.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Continuous Ultrasonic Rail Defect Identification Inspection | As defined in SPEC-073-C-12001 | | |

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

### 3.7.3. Reference Documents

| | |
|---|---|
| SPEC-073-C-12000 | Non-Destructive Testing Ultrasonic Testing –General Requirements |
| SPEC-073-C-12001 | Non-Destructive Testing of In Track Rail & Rail Welds via Rail Flaw Detection Vehicle |
| SPEC-073-C-12002 | Non-Destructive Testing Ultrasonic Testing –Hand Testing of Rail Welds and Rail |
| SPEC-073-C-12003 | Non-Destructive Testing Magnetic Particle Testing – General Requirements |
| SPEC-073-C-12004 | Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast |
| SPEC-073-C-12005 | Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast- Rail Flashbutt Welds |
| SPEC-073-C-12006 | Rail Defects – Classification of Defects and Assessment of Defect Severity |
| SPEC-073-C-12007 | Defects – Classification of Rail Surface Condition Associated with Rolling Contact Fatigue Damage |
| 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 |
| 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,
- Bogholes 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,
- 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;
- indicative deterioration rates.

Note that ballast profile shall be monitored during visual track inspections. OPPORTUNITY – Ballast profile to be measured with a new generation Track Condition Monitoring Vehicle (due 2016).

## 3.8.2. 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 inspection | As required | As required | NA |

### 3.8.3. Inspector

The person carrying out the trial pit ballast inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in identifying ballast fouling;
- be knowledgeable regarding this code of practice.

The person carrying out the ground penetrating inspection shall:

- be expertly trained and competent in executing ground penetrating radar inspections;
- 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 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.

Switch and crossing 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, 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.

During switch and crossing inspections the slide chair plates shall be cleaned and lubricated using ‘dry’ graphite based lubrication.

In general, the following shall be checked during an inspection of a switch and crossing assembly:

- 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,
- 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. Note that exceedance of thresholds in Section 4.6 require immediate response:

| | |
|---|---|
| TURNOUT ASSEMBLIES | |
| missing or broken components | incorrect track geometry |
| inadequate track centre to track centre at fouling points | rail and weld wear and defects |
| 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 | 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 |
| mis-alignment 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 |
| poor condition of switch rail stops | poor rail joint condition including bolts |
| SWITCH OPERATION | |
| 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 | inadequate lubrication of all movable pins and bolts |
| poor spreader bar condition, straightness, insulation, correct adjustment and clearance under rails | |
| CROSSING | |
| inadequate gauge at critical areas | running rail wear |
| inadequate check rail effectiveness | metal flow |
| vertical wear on the crossing nose | poor crossing nose condition |
| inadequate flangeway clearances | crossing cracks |
| inadequate flangeway depth | broken or cracked crossing spacer blocks |
| wing rail wear | poor condition of check rail spacers |
| poor rail alignment | poor condition of check rail and crossing bolts |

| FASTENINGS | |
|---|---|
| damaged fastenings (e.g. from incorrect installation, derailment, vandalism) | missing, ineffective (e.g. corrosion, wear, loose), incorrect type of fastenings (clips, insulating spacers, metal spacers, pads and special components including gaskets and abrasion plates) |
| 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 |
| poor bearer condition | insecure, damaged, missing or poor condition signalling components |
| poor check rail condition | |

### 3.9.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Switch and Crossing Walk-through Inspection | 2/week | 2/week | 2/week |
| Switch and Crossing Detailed Inspection | 3 months | 3 months | 6 months |

### 3.9.3. Inspector

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in identifying track defects;
- have knowledge of local factors;
- 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 (OPPORTUNITY)

## 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. Note 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,
- 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,
- 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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Rail Stress Testing | As required | As required | NA |
| Rail Creep Monitoring | Continuous at locations with known rail movement problems | NA | NA |

## 3.10.3. Reference Documents

| | |
|---|---|
| WIN 010866 | Work Instruction - Rail Stress Testing |

### 3.10.4. Inspector

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in the use of the track stress recording or rail creep monitoring equipment;
- have knowledge of local factors;
- 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 and 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;
- 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. Non-Destructive Weld Testing

All new welds installed in the field (not including fixed flashbutt welds) shall be magnetic particle tested immediately after installation. Non-destructive testing for internal rail defects shall be carried out 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.

Upon completion of the testing the weld shall be marked with indelible white paint dots placed on the rail at the weld on both the field and gauge faces of the rail. The test date, test details and operator details shall be written with indelible white paint pen in the web next to the weld.

### 3.11.1.3. Production Flashbutt Weld Testing

All mobile flashbutt welding machines shall be subjected to production weld tests as set out in SPEC-000-C-12002.

## 3.11.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Visual Inspection at Installation | Immediate after Installation | Immediate after Installation | Immediate after Installation |
| Magnetic Particle Testing | Immediate after Installation | Immediate after Installation | Immediate after Installation |
| Non-Destructive Testing | Within 14 days of installation | Within 14 days of installation | As Required |

### 3.11.3. Reference Documents

| | |
|---|---|
| AS 2083 | Calibration of Equipment |
| AS 1085.20 | Weld Test Procedure |
| SPEC-073-C-12002 | Non-Destructive Testing Ultrasonic Testing –Hand Testing of Rail Welds and Rail |
| SPEC-073-C-12003 | Non-Destructive Testing Magnetic Particle Testing – General Requirements |
| SPEC-073-C-12004 | Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast |
| SPEC-073-C-12005 | Non-Destructive Testing Magnetic Particle Testing – Hand Yokes Colour Contrast- Rail Flashbutt Welds |
| SPEC-073-C-12006 | Rail Defects – Classification of Defects and Assessment of Defect Severity |

### 3.11.4. Inspector

The person carrying out the visual weld inspection shall:

- be suitably qualified as per SPEC-000-C-12000;
- be a trained and competent BHPB Rail Welder;
- be assessed as having working knowledge of weld failure mechanisms;
- assessed as being competent in using this Code of Practice.

The person carrying out the non-destructive weld testing shall:

- be suitably qualified in the use of the testing equipment as per SPEC-000-C-12000.

### 3.11.5. Documentation

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

Public Access Level Crossings shall be reviewed every 5 years to ensure significant changes in traffic volumes have not changed the level of protection or design required.

### 3.12.2. Inspection Frequency

TABLE 3-4 LEVEL CROSSING (PUBLIC ACCESS) INSPECTION FREQUENCY

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| General inspection | 12 weeks | 12 weeks | NA |
| Detailed inspection | 2 years | 2 years | NA |
| Review of Design and Level of Protection | 5 years | 5 years | NA |

TABLE 3-5 LEVEL CROSSING (PRIVATE ACCESS) INSPECTION FREQUENCY

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| General inspection | 6 months | 6 months | 2 years |
| Detailed inspection | 2 years | 2 years | NA |

Note that 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, to minimise disruption.

### 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 2 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,
- 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 3-6. 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 and in addition identifying conditions or changes in the conditions which may affect the function of the bridge including 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,
- 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,
- 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 3-6 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

| | |
|---|---|
| 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 |
| 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 – 2001 | 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 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 to allow necessary actions to be determined. 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 the earthwork instability, and correctly specifying the required remedial works.

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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Earthworks Inspection | As required | | |
| Special Location Scheduled Earthworks Inspection | Scheduled frequency based upon historic performance and current condition of the special location, but not exceeding 6 months | | |

## 3.14.3. Inspector

The person carrying out the inspection shall:

- be a suitably qualified Civil Engineer, experienced in earthworks;
- be competent in identifying earthwork defects;
- 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,
- depth of water a creek crossings (particularly important following extended periods of wet weather or significant rain events).

## 3.15.2. Inspection Frequency

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Access Road Inspection | As required following significant events, but not exceeding 4 weeks | | |

### 3.15.3. Reference Documents

| | |
|---|---|
| WIN-RTS-PMI-001 | Daily Access Roads Inspection (Road Signage and Guide Posts) |
| WIN-RTS-PMI-002 | Daily Access Roads Inspection (Road Surface & Culverts) |
| WIN-RTS-PMI-003 | 6 Monthly Access Roads Inspection |
| 0106581 | Inspecting Access Roads |
| WIN-RTS-RTM-149 | Daily Access Road Inspections |
| WIN-RTS-RTM-150 | 6 Monthly Access Road Inspections |

### 3.15.4. Inspector

The person carrying out the inspection shall:

- be suitably qualified to drive on the BHPBIO access road,
- have knowledge of local factors;
- 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 as long as the speed of inspection is adjusted accordingly to provide adequate time to execute the inspections.

## 3.16.2. 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

| | |
|---|---|
| WIN - 0071998 | Stat Inspect Signage |

## 3.16.4. Inspector

The person carrying out the inspection shall:

- be suitably qualified to a minimum Cert 3 Rail Infrastructure level;
- be competent in identifying required signage;
- have knowledge of local factors;
- 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 also 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,
- 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 take into account 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

| 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

| | |
|---|---|
| 076-M-01285 | Rolling Stock Handbook Index Page |
| 076-M-01286 | Loading Gauge and Structure Clearance Diagrams |
| 076-M-01287 | Loadout Tunnel Clearance Diagrams |
| 000-M-00067 | Railway Rolling Stock Line Clearance Diagram |
| DESC-000-C-00001 | Design Criteria Track Design |
| CD - 0119120 | RRB M07 Service & Work Trains |

### 3.17.4. Inspector

The person carrying out the inspection shall:

- be suitably qualified to carry out clearance measurements;
- have knowledge of local factors;
- 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 rain storm, sustained heavy rainfall or flooding,
- cyclone,
- seismic activity,
- fire,
- derailment,
- track obstruction,
- landslides,
- structural collapse,
- 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,
- 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

| INSPECTION TYPE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| MAJOR RAIN EVENT AND/OR CYLCONE / 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

| | |
|---|---|
| CD 0121599 | WAIO Extreme Weather Procedure |
| CD 0113700 | Track and Signals Cyclone Procedure |

## 3.18.4. Inspector

The person carrying out the inspection shall comply with the requirements in the part of Section 3 covering the relevant inspection type.

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,
- fallen power lines.

### 3.18.5. 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.

TABLE 4-1 DEFECT RESPOPNSE CODES

| RESPONSE CODE | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| A | CLOSE TRACK UNTIL REPAIRED<br>OR<br>PROTECT AND TREAT AS RESPONSE CODE B | Close Track until repaired<br>or<br>Protect and treat as Response Code B | Close Track until repaired<br>or<br>Protect and treat as Response Code B |
| B | APPLY 25KPH TSR<br>PROTECT IF REQUIRED<br>CARRY OUT INSPECTION OF THE DEFECT AND PROTECTION (IF APPLICABLE) DAILY UNTIL REPAIRED | Apply 10kph TSR<br>Protect if required<br>Carry out inspection of the defect and protection (if applicable) daily until repaired | Apply 10kph TSR<br>Protect if required<br>Carry out inspection of the defect and protection (if applicable) daily until repaired |
| C | APPLY 45KPH TSR<br>PROTECT IF REQUIRED<br>CARRY OUT INSPECTION OF THE DEFECT DURING SCHEDULED INSPECTIONS UNTIL REPAIRED | Apply 25kph TSR<br>Protect if required<br>Carry out inspection of the defect during scheduled inspections until repaired | Apply 25kph TSR<br>Protect if required<br>Carry out inspection of the defect during scheduled inspections until repaired |
| D | APPLY 60KPH TSR<br>PROTECT IF REQUIRED<br>CARRY OUT INSPECTION OF THE DEFECT DURING SCHEDULED INSPECTIONS UNTIL REPAIRED | Apply 45kph TSR<br>Protect if required<br>Carry out inspection of the defect during scheduled inspections until repaired | NA |
| E | PROTECT IF REQUIRED<br>MONITOR FOR DETERIORATION OF DEFECT DURING SCHEDULED INSPECTIONS UNTIL REPAIRED | Protect if required<br>Monitor for deterioration of defect during scheduled inspections until repaired | Protect if required<br>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 24hrs 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 Day Month 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. Repair Timeframes

For some defect types a recommended 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 should be followed. For example:

(24h) Rectification works should be carried out within 24 hours,

(4w) Rectification works should be carried out within 4 weeks,

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

If repair timeframes cannot be achieved direction should be sought from Senior Track Engineer for guidance on prioritisation of works.

### 4.1.2. 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 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 G clamps,
- Install Robel clamps (Opportunity),
- 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 rail mini-plug.

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.

For containment of severity 1 / broken rail a 600mm plug may be installed as per WIN-RTS-RTM-076.

### 4.1.3. Ultrasonic Defect Severity Identification

If defects with specific severity levels require location demarcation on track then the following colour coding shall be used. 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 |

## Page Intentionally Left Blank

# 4.2. TRACK GEOMETRY AND STABILITY

## 4.2.1. Geometry

TABLE 4-3 GEOMETRY PARAMETER DESCRIPTIONS (EM80)

| PARAMETER | DESCRIPTION |
|---|---|
| Gauge | Gauge is measured between the gauge (or inside) face of the rails 14 mm below the surface of the rail. |
| Horizontal Alignment | Horizontal alignment 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 | 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 (EM80) 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.

TABLE 4-4 GEOMETRY DEFECTS TOP

| PARAMETER | RESPONSE (SEVERITY) | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Top | E (Sev 3) | 15mm | 20mm | 20mm |
| | D (Sev 2) | 20mm | 25mm | 25mm |
| | A (Sev 1) | 36mm | 36mm | 36mm |

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

TABLE 4-5 GEOMETRY DEFECTS HORIZONTAL ALIGNMENT

| PARAMETER | RESPONSE (SEVERITY) | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Horizontal Alignment | E (Sev 3) | 18mm | 24mm | 24mm |
| | D (Sev 2) | 24mm | 34mm | 34mm |
| | A (Sev 1) | 43mm | 45mm | 45mm |

TABLE 4-6 GEOMETRY DEFECTS WIDE GAUGE

| PARAMETER | RESPONSE (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 |

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.

Should static gauge be measured on timber sleeper track at or greater than 1458mm action must be taken to restore within maintenance limits within 36 hours of identification.

TABLE 4-7 GEOMETRY DEFECTS TIGHT GAUGE

| PARAMETER | RESPONSE (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 (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 (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 (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 (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 (SEVERITY) | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Cross Level (Curve 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 (Opportunity)

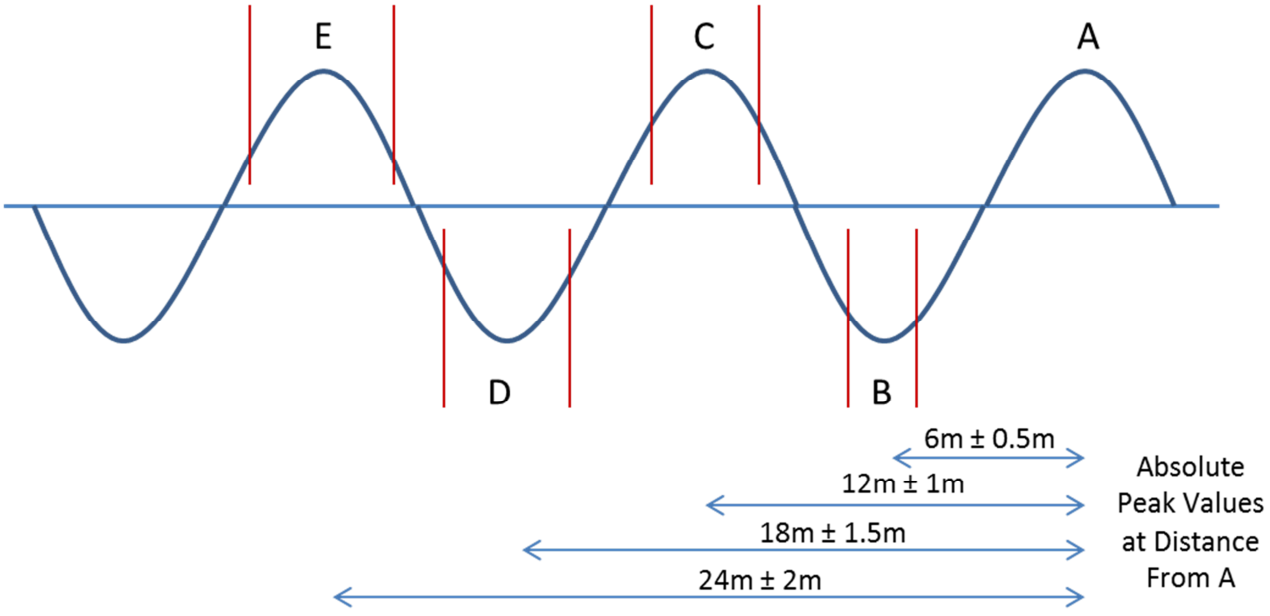
Cyclic geometry defects are known to present an increased risk of derailments when they result in increased dynamic response of rail traffic, in particular ore cars, at a wavelength of approximately 12m.

Cyclic geometry defects shall to 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;
- ≥ 6 mm Top.

In order 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 Condition Index (Under Review – Conversion to SD)

Track Condition Index (TCI) is a single unit of measurement of geometry related Track Condition of any 100 metre segment of track. This value is calculated through the application of weightings to returned geometrical measurements. Geometrical parameter weightings have been defined based on their influence to track performance.

TCI is categorised into four quality bands as shown in 4.12

TABLE 4-13 TRACK CONDITION INDEX QUALITY BANDS

| QUALITY BAND | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Good | < 11.9 | 12 – 19.9 | NA |
| Satisfactory | 12 – 19.9 | 20 – 24.9 | NA |
| Poor | 20 – 24.9 | 25 < | NA |
| Very Poor | 25 < | 30 < | NA |
| Urgent Maintenance | 30 < | NA | NA |

### 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 axel 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 4-14 defines the maximum track deflection observed and the applicable defect responses.

TABLE 4-14 MAXIMUM TRACK DEFLECTION

| DEFLECTION | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Deflection > 7mm | E | NA | NA |
| Deflection > 12mm | D (2w) | E (2w) | NA |
| Deflection > 20mm | C (2w) | D (2w) | E |
| Deflection > 30mm | B | C | C |

### 4.2.5.2. Clusters of Consecutive Pumping Sleepers

Where clusters of consecutive pumping sleepers are observed, Table 4-15 defines the applicable defect responses. These should be considered in conjunction with Table 4-14 and the most conservative response applied.

Table 4-15 considers that maximum deflection of at least one sleeper exceeds the minimum deflection specified in Table 4-14.

TABLE 4-15 CLUSTERS OF CONSECUTIVE PUMPING SLEEPERS

| NUMBER OF CONSECUTIVE PUMPING SLEEPERS | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| 3 - 5 | D | E | |
| 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 4-16 INSTRUMENTED ORE CAR DEFECTS

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Bounce (mm) | ≥ 8mm | E | NA | NA |
| | ≥ 10mm | E | E | NA |
| | ≥ 12mm | D | E | E |
| Body Rock (mm) | ≥ 12mm | E | NA | NA |
| | ≥ 15mm | E | E | NA |
| | ≥ 18mm | D | E | E |
| Sideframe Acceleration (g) | ≥ 25g | E | NA | NA |
| | ≥ 40g | E | E | NA |
| | ≥ 50g | D | E | E |
| Suspension Travel (mm) | ≥ 12mm | E | NA | NA |
| | ≥ 15mm | E | E | NA |
| | ≥ 18mm | D | E | E |

## Page Intentionally Left Blank

# 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 wear shall be used when determining appropriate responses.

Rail wear limits specified in Table 4-17 to Table 4-20 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;
- Presence and density of other weak points such as welds.

### 4.3.1.1. Top 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 4-17 68KG/M RAIL TOP WEAR LIMITS

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Curve < 900m Radius | Top Wear > 8.7mm | E | E | E |
| | Top Wear > 12.7mm | C | D | E |
| | Top Wear > 13.7mm | A | A | A |
| Curve ≥ 900m Radius Tangent | Top Wear > 11.7mm | E | E | E |
| | Top Wear > 15.7mm | C | D | E |
| | Top Wear > 16.7mm | A | A | A |

### 4.3.1.2. Rail Height Limits

Rail Height defects are a result of top wear. The values shown in the table below are applicable to both 68kg/m and 71kg/m rail.

TABLE 4-18 RAIL HEIGHT LIMITS

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Curve < 900m Radius | Rail Height < 177mm | E | E | E |
| | Rail Height < 173mm | C | D | E |
| | Rail Height < 172mm | A | A | A |
| Curve ≥ 900m Radius Tangent | Rail Height < 174mm | E | E | E |
| | Rail Height < 170mm | C | D | E |
| | Rail Height < 169mm | A | A | A |

### 4.3.1.3. Side Wear Limits

Side wear is measured 15 mm below the running surface. The values shown in the table below refer to 68kg/m rail.

TABLE 4-19 68KG/M RAIL SIDE WEAR LIMITS

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| All | Side Wear > 18mm | E | E | E |
| All | Side Wear > 22mm | C | D | E |
| All | Side Wear > 23mm | A | B | B |
| Curve High Rail | Side Wear > 33mm | 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;
- top wear and head area wear limits are not exceeded.

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

#### 4.3.1.4. Head Area Wear Limits

The limit of head area loss is 40% before mitigating actions need to be taken. To facilitate calculation of rail head area loss in the field the following method shall be applied.

Head area loss shall be calculated by combining together the top and side wear measurements at a given location. For example:

TC1 Example 1 Top Wear = 13mm
Side Wear = 10mm
**Total = 23mm LIMIT**

TC3 Example 2 Top Wear = 1mm
Side Wear = 32mm
**Total = 33mm LIMIT**

TABLE 4-20 RAIL HEAD AREA WEAR LIMITS

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| All | (Top + Side Wear) > 18mm | E | E | E |
| All | (Top + Side Wear) > 22mm | C | D | E |
| All | (Top + Side Wear) > 23mm | A | B | B |
| Curve High Rail | (Top + Side Wear) > 33mm | NA | A | A |

Note: if top wear exceeds the limits specified in Table 4-17response code shall be applied as per Table 4-17.

### 4.3.2. Gauge Face Angle

TABLE 4-21 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 (Under Review)

TABLE 4-22 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 reoccurring 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,
- 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 4-23 RAIL SURFACE IRREGULARITIES

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Peak (Weld)<br>Measured with 1m straight edge and Starret Gauge | > 0.5mm | E | E | NA |
| Dip | > 0 mm | E | E | NA |

| | | | | |
|---|---|---|---|---|
| Weld Alignment (Gauge Face)<br>Measured with 1m straight edge and Starret Gauge | > ±0.5 mm | E | E | NA |
| Weld Colour | Blue Weld (ground too hot) | E | E | NA |
| AT Weld Position Within Crib | Touching Sleeper | E | E | NA |
| Head Spalling / Shelling | Visible | E (Sev 3) | E (Sev 3) | E (Sev 3) |
| Weld Break Out<br>(field side of rail) | Any loss of weld on the field side of a rail | E<br>Clamp within 24 hours | E<br>Clamp within 24 hours | NA |
| Wheel Burns | Visible | E | E | NA |
| Corroded Rail | > 3mm section loss in web or foot | E (7d) | E | E |

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 (Opportunity)

Once Rail has been identified as untestable by ultrasonic rail inspection the following immediate actions / controls shall be applied:

- Place a 25 km/h TSR on the specific section of track,
- Ensure that the responsible track department supervisor has been informed. The track department supervisor will then proceed to initiate TSR boards & transponders to the specific location if required,
- Track department supervisor shall inform the Major Works Contracts Supervisor / Coordinator 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,
- Major Works Contracts Supervisor / Coordinator inform ultrasonic rail inspections team, track has been ground and awaiting testing,
- Track is tested by ultrasonic rail inspection, if track is tested and is deemed satisfactory the TSR can be removed,
- Ultrasonic rail inspections team inform the Track Department 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 SPEC-073-C-12006.

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

TABLE 4-24 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)<br>See note below | A | A |
| 2 | 24h | E (14d) | E | E |
| 3 | 4d | E (28d) | E | E |

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 mini-plug may be installed as a temporary form of protection:

- 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;
- wheel burn.

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

### 4.3.6. Profile

The following table defines the defects and responses for the rail grinding quality index, as calculated by the mainline grinding machine.

TABLE 4-25 GRINDING QUALITY INDEX DEFECTS

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Grinding Quality Index | < 90 | E | E | E |

Table 4-26 defines the weightings to be applied to measurements taken from different parts of the rail head for different track geometry applications when calculating the Grinding Quality Index.

TABLE 4-26 GRINDING QUALITY INDEX CALCULATION WEIGHTINGS

| APPLICATION | GAUGE +60º TO +10º | CENTRE +10º TO -3º | FIELD -3º TO -16º |
|---|---|---|---|
| Tangent | 40% | 55% | 5% |
| Curve – High Rail | 40% | 55% | 5% |
| Curve – Low Rail | 15% | 60% | 25% |

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

TABLE 4-27 RAIL PROFILE DEFECTS (MANUAL MEASUREMENT)

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Gauge +60º to +10º<br>Field -3º to -16º<br>(Non-Contact Areas) | > 0.40mm | E | E | E |
| +10º to -3º<br>(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 mini-prof.

TABLE 4-28 RAIL PROFILE DEFECTS (ELECTRONIC MEASUREMENT)

| APPLICATION | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Gauge +60° to +10°<br>Field -3° to -16°<br>(Non-Contact Areas) | > 0.20mm | E | E | E |
| +10° to -3°<br>(Running Band) | > 0.15mm | E | E | E |
| +10° to Gauge Corner Reference Point | > 0.15mm | E | E | E |

## Page Intentionally Left Blank

# 4.4. SLEEPERS AND FASTENINGS

## 4.4.1. Missing/Non-load Bearing Sleepers

Table 4-29 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 to, but not necessarily, 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 4-29 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 that Table 4-29 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 4-30 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;
- 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.

TABLE 4-30 INEFFECTIVE FASTENINGS SINGLE RAIL

| 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 |

TABLE 4-31 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 that Table 4-30 does not apply to missing sleepers or sleepers failing to provide any vertical support. See Table 4-29 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.

# 4.5. BALLAST

## 4.5.1. Depth

Deviations from the parameters set out in Section 0 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, sleeper 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. Shoulder Profile

The responses in Table 4-32 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, track speed.

TABLE 4-32 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<br>Or<br>200mm ≥ H > 125mm | E | NA | NA |
| 150mm ≥ W > 75mm<br>Or<br>125mm ≥ H > 65mm | D | E | NA |
| W ≤ 75mm<br>Or<br>H ≤ 65mm | B | C | E<br>A (timber) |
| H ≤ 0mm | A | A | A |
| CURVES < 900M RADIUS, TURNOUTS < 1:20 | | | |
| 375mm ≥ W > 250mm<br>Or<br>200mm ≥ H > 125mm | E | NA | NA |

| DEFECTIVE BALLAST PROFILE OVER LENGTH OF > 10M | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| 250mm ≥ W > 125mm<br>Or<br>125mm ≥ H > 65mm | D | E | NA |
| W ≤ 125mm<br>Or<br>H ≤ 65mm | B | C | E<br>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,
- Rail size of 68 kg/m and CWR/LWR (>110 metre) rail lengths.

### 4.5.3. Quality/Fouled

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. Generally 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,
- 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 13.5mm 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;
- other external factors.

A notification shall be raised to rectify the inadequate ballast conditions.

### 4.5.4. Bogholes

Bogholes shall be assessed for defect responses against the track pumping and geometry defect parts of Section 4.

## 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 4-33 and Table 4-34 respectively.

Definition of worn and defective switch and crossing conditions and critical areas for geometry are shown in 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,
- 4.7 Mechanical Rail Joints.

Where the condition identified is only a hazard for the facing condition the speed restriction is only required for the facing movement.

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 that Table 4-34 does not apply to wheel flange bearing crossing designs.

TABLE 4-33 SWITCH AREA DEFECT RESPONSES

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| SWITCH RAIL THROAT OPENING DIMENSION (JUNCTION OF HEADS) | | | | |
| Back of switch rail to stock rail (actual dimension) | < 40mm | C | D | E |
| Note: Additional action maybe required for signalling purposes where the switch rail throat opening dimension is less than 50 mm. | < 35mm | A | A | A |
| SWITCH RAIL TOE/STOCK RAIL DIMENSION | | | | |
| Open throw dimension | < 110mm | E | E | E |
| Note: Additional action maybe required for signalling purposes. | < 100mm | B | C | C |

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| An alternative action to those specified is to prohibit facing train movements. | < 90mm | A | A | A |
| TRACK GAUGE (AT THE SWITCH TIP) | | | | |
| Track Gauge dimension<br>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 |
| KEY COMPONENT CONDITION | | | | |
| Heel block<br>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 and ineffective | A | A | A |
| Broken/Ineffective rail brace/chair | 2 consecutive | D | NA | NA |
| | > 2 consecutive | A | A | A |
| Missing/Ineffective Switch bearing stops<br>(To avoid rail roll-over) | 2 consecutive | D | E | E |
| | > 2 consecutive | A | A | A |
| Ineffective bearers/ fasteners<br>(in critical area)<br>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<br>Note: An alternative action that may be taken is to install a switch clip in accordance with safe working rules. | Missing/broken | A | A | A |
| 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 RAIL / STOCK RAIL SET<br>Notes:<br>An alternative action to those specified is to prohibit facing train movements on the relevant rail of the turnout.<br>Applies to conventional switches only (i.e. not undercut switches).<br>When a worn switch at the end of its service life is being replaced a new switch and stock rail set should be used. | | | | |

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Switch blade damage<br>(Length of defect with depth > 19 mm from the running surface, anywhere in the switch blade)<br>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 |
| Stock or switch rail gauge face angle (from vertical at the point of wheel flange/rail contact at the switch tip area)<br>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 |
| Switch rail angle<br>(from horizontal at any point between 19 mm and 30 mm below the running surface of the stock rail) | < 40deg. | A | A | A |
| Stock rail gauge face wear<br>(Where the switch rail contacts the stock rail at gauge point) | 2mm | E | E | E |
| | ≥ 3mm | E | E | E |
| | 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. | | | |
| Switch tip height<br>(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 at tip<br>(As presented to the wheel)<br>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. | ≥ 4mm | E | E | E |
| | ≥ 6mm | B | C | C |
| | ≥ 9mm | A | A | A |

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| 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 | | |
| 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. | | |

## TABLE 4-34 CROSSING AREA DEFECT RESPONSES

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| CHECK RAIL EFFECTIVENESS<br>Notes:<br>An alternative action to those specified is to prohibit facing train movement.<br>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 | NA | NA |
| | < 1386mm | D | E | NA |
| | < 1384mm | C | D | E |
| | < 1382mm | A | A | A |
| CROSSING NOSE | | | | |
| Vertical wear | > 5mm | E | E | NA |
| | > 10mm | C | D | E |
| WING RAIL | | | | |
| Vertical wear | > 5mm | E | E | NA |
| | > 10mm | C | D | E |
| TRACK GAUGE<br>Note:<br>For wide gauge in the crossing critical area plain track limits also apply. | | | | |
| Track gauge at the crossing nose | < 1430mm | E | NA | NA |
| | < 1427mm | D | E | E |
| | < 1425mm | B | C | C |
| KEY COMPONENT CONDITION | | | | |
| Broken crossing nose within transfer length<br>(width of break) | > 15mm | E | E | NA |
| | > 20mm | C | D | E |
| | > 25mm | A | A | A |
| Ineffective bearers/fasteners<br>(in critical area) | 1 only | E | E | NA |
| | 2 consecutive | C | D | E |

| PARAMETER | DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|---|
| Note: Refer to Section 4.4 for the definition of “ineffective” sleepers and bearers | > 2 consecutive | A | A | A |
| Spacer blocks | Broken/cracked | E | E | E |
| Cracks in cast crossings | Critical<br>longitudinal or vertical crack that may lead to a piece of crossing eventually lifting or breaking out and affecting the running surface integrity | E | NA | NA |
| | Fully<br>(not affecting the running surface)<br>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 | NA |
| | Fully<br>(affecting the running surface)<br>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<br>Note: The end bolts of all check rails should be effective. | Loose | E | E | E |
| | Missing/ineffective: ≤2 | E | NA | NA |
| | Missing/ineffective: 3 | D | E | E |
| | Missing/ineffective: >3 | B | C | C |
| 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 4.2 | | | |

## 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 4-35 FISHPLATE CRACKS AND BREAKS

| DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| 1 or both fishplates partially cracked | B (with protection*) | C (with protection*) | C (with protection*) |
| 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 the response shall be based on the track support conditions and whether the insulated rail joint type can be protected using plates and clamps. If the insulated rail joint cannot be protected then the joint shall be replaced within 24 hours.

### 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 4-36 MISSING, INEFFECTIVE AND LOOSE BOLTS

| DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| 1 missing, ineffective or loose bolt | E (6w) | E | NA |
| 2 missing, ineffective or loose bolts | C (14d) | D | E |
| 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 | 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 G 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 4-38.

TABLE 4-37 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 (24h) |
| Gap > 30mm | A | A | A |

Where joint gap defects are identified a competent inspector shall check for fishplate and fishbolt 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 4-38 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 4-39 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,
- 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 4-40 RAIL JOINT DEFLECTION DEFECTS

| DEFECT | TRACK CATEGORY 1 | TRACK CATEGORY 2 | TRACK CATEGORY 3 |
|---|---|---|---|
| Deflection > 7mm | E (6w) | E (6w) | NA |
| Deflection > 12mm | D (2w) | E (2w) | E |

Note that all deflections of insulated rails joints greater than 7mm require an “Insulated Joint Deflection” form to be completed and sent to the Track and Signals Analysis and Improvement team.

## 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;
- 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 BHPBIO 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;
- operational restrictions should be imposed.

TABLE 4-41 SIGN REPAIR TIMEFRAMES

| SIGN TYPE | REPAIR TIMFRAMES |
|---|---|
| SAFETY SIGNAGE | |
| Temporary Speed Restriction | 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 SIGNS | |
|---|---|
| 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.

## 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 4-42 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 |

# 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 (Opportunity)

Rail shall be replaced based upon the following conditions:

- The extent of rail wear is approaching the wear limits,
- 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,
- 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

| | |
|---|---|
| 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 | Repl 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;,
- 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.

## 5.3. 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.

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

When installing a rail plug as a repair the rail plug should match the rail in track in terms of profile, type and wear. Any mismatch in rail type shall be recorded in 1SAP.

When installing on tangent track the rail plug shall be a minimum of 6m in length. When installing on a curve the rail plug shall be a minimum of 9m in length.

In turnouts welds are to be a minimum of 1.2 m from another weld or rail joint (mechanical or glued) provided that the weld or joint is ultrasonically tested and no defects are found. For this application a turnout is considered to be from the centre of the arrival insulated rail joint to the centre of the departure insulated rail joint.

## 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 |
|---|---|
| Dip in running surface | The rail containing the defect shall be removed and replaced<br>or<br>the defect shall be removed by lifting |
| Gauge widening due to change in rail | The rail containing the defect shall be removed and replaced<br>or<br>the defect shall be removed by bending the rail |
| Gauge narrowing due to change in rail | The rail containing the defect shall be removed and replaced<br>or<br>the defect shall be removed by grinding |
| Peak in running surface | |
| Vertical deviation in rail running surface (Ramp angle) | |
| Vertical step in rail running surface | |
| Horizontal step in rail running surface | |
| Wheel burn | |

| RAIL DEFECT TYPE | STRATEGY |
|---|---|
| Gauge face angle exceeds defect limits over a length of more than 2m | The rail containing the defect shall be removed and replaced |
| Bolt hole (crack, elongation or non-conforming) | |
| 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) | |
| Shatter crack | |
| 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 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 | 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 |

### 5.4.3. Reference Documents

| | |
|---|---|
| WIN-RTS-RTM-129 | Re-railing (Lengths of 25m or less) |
| WIN - 0096245 | Repl Rail |
| WIN-RTS-RTM-076 | Clamp Rail Defect and Installation of Mini-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) |

# 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, 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,<br>Respace sleepers (if required),<br>Repair or replace rail joint,<br>Restore ballast profile,<br>Hand tamp joint | Within 6 weeks |
| Deflection > 12mm | Replace ballast if condition exceeds thresholds,<br>Respace sleepers (if required),<br>Repair or replace rail joint,<br>Restore ballast profile,<br>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 BHPBIO specifications and tested and approved prior to use on the BHPBIO 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 BHPBIO 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,
- 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 of the welding activity;
- reassessment of the welding process;
- 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 (Under Review)

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

| | |
|---|---|
| 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.

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.

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 (Under Review)

Notes for potential inclusion:

- Possessions for plain line and turnout tamping shall be planned on cyclical basis based upon historic work requirements,
- Specific sites requiring tamping shall be identified using track geometry condition data,

- Minimum 1km site length for Plain Line Tamping,
- Record geometry left behind using rear trolley and check for compliance with required quality.

When extreme weather events are forecast to impact the BHPBIO Railroad then tamping machines shall be stabled towards each end of the BHPBIO Railroad for the purpose of repair of any potential wash-away. It is recommended machines are stabled towards each end of the railroad in locations that are not susceptible to flooding.

### 5.7.3. Reference Documents

| | |
|---|---|
| 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 appropriate Rail Grinding Specification, SPEC-077-M-00002.

## 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.

Grinding frequency of the straight through a turnout shall be based upon the tonnage traversing the adjacent track section on the arrival side of the turnout. The grinding effort required on the diverge of the turnout shall be based upon the amount of wear present. The profile shall be rectified and damage removed in compliance with requirements discussed below in terms of rail removal and defect removal.

Turnout grinding activities shall extend to encompass the arrival and departure insulated rail joint locations and a minimum of 10m beyond.

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 other than that defined as special sites.

TABLE 5-3 RAIL GRINDING MGT FREQUENCIES

| CURVATURE | GRADE | FREQUENCY | MINIMUM METAL REMOVAL |
|---|---|---|---|
| Curves < 900m | All | 15 MGT | 0.40mm from the main contact band of the rail |
| Curves ≥ 900m and < 2600m | All | 22 MGT | 0.20mm from the main contact band of the rail |
| Curves ≥ 2600m to Tangent, Turnouts | Uphill travelling towards port | 33 MGT | 0.20mm from the main contact band of the rail |
| Curves ≥ 2600m to Tangent, Turnouts | Level or downhill travelling towards port | 50 MGT | 0.20mm from the main contact band of the rail |

Level crossings are to ground at the same frequency as the track either side of the level crossing in accordance with the above table.

Note that the requirement related to grade travelling towards port makes the assumption that loaded trains travel towards port. For parts of the BHPBIO Railroad where this is not the case then the direction of loaded travel shall be considered in assigning grinding frequencies.

The table above specifies the minimum metal removal during a grinding maintenance activity. Sufficient metal shall be removed to ensure that minor surface defects such as rolling contact fatigue, shelling, pitting, wheel burns and corrugation are controlled, up to the maximum pre-approval metal removal limit.

The maximum pre-approval metal removal shall be 0.50mm from the main contact band of the rail. If a rail surface defect remains following the removal of 0.50mm of metal then further assessment is required by a trained and competent person prior to approval being granted to remove more metal. A further 0.30mm can be removed (to a total of 0.80mm) following the assessment of:

- the rail height and wear;
- the current traffic volumes and grinding frequencies;
- current geometry defects and concerns.

The target surface defect removal strategy, within the limitations of the metal removal quantities, is a minimum of 95% defect removal from rail during a single maintenance activity. Removal of less than this requires a notification to be raised in 1SAP for the rectification of the defect at a later date.

Due to the complexities of planning track access and support maintenance in some areas of the network (such as mine balloon loops) time based grinding frequencies are used to enable longer planning horizons. These sites are treated as special sites and should be monitored to ensure that the time based frequencies provide sufficient grinding maintenance and are regularly assessed against the MGT profile.

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.

TABLE 5-4 RAIL GRINDING SPECIAL SITES

| LOCATION | FREQUENCY |
|---|---|
| Mine Loops | 6 months |
| Newman Yard | 1 year |
| Hedland Yard | 1 year |
| Mooka Staging Facility | 1 year |

#### 5.8.2.1. Grinding Newly Installed Rail

All newly installed rails, including on tangent and curved track and turnouts require grinding prior to the passage of 8MGT of traffic.

If tangent track cannot be ground prior to 8MGT of traffic then it shall be ground prior to the passage of 15MGT of traffic and shall be monitored until completed.

### 5.8.3. Tolerances of Finish

TABLE 5-5 GRINDING PROFILE TOLERANCES

| TYPE | 0º TO 20º | 20º TO 60º | NEGATIVE ANGLES |
|---|---|---|---|
| High Rail | ±0.10 mm | ±0.10 mm | ±0.15 mm |
| Low Rail | ±0.10 mm | ±0.15 mm | ±0.15 mm |
| Tangent | ±0.10 mm | ±0.10 mm | ±0.15 mm |
| Switches | ±0.10 mm | ±0.10 mm | ±0.15 mm |

### 5.8.4. Reference Documents

| | |
|---|---|
| SPEC-077-M-00002 | Rail Grinding Machine Specification |

## 5.9. RAIL STRESS CONTROL (OPPORTUNITY)

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;
- 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;
    - 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 5-6 STRESS ADJUSTMENT BASED ON CURVE RADIUS

| CURVE RADIUS | MAXIMUM LENGTH OF ADJUSTMENT |
|---|---|
| > 1600m to tangent | 500 metres |
| 400m < to ≤ 1600m | 300 metres |
| ≤ 400m | 150 metres |

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.

# 6. TERMINOLOGY

| | |
|---|---|
| AT | Aluminothermic Weld |
| 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 |
| Catchpoint | A single or double blade switch placed on a siding to protect the mainline by derailing rail traffic that may enter or foul an adjacent running line |
| Check rails | 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. |
| 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 (lines) | Lines meeting and joining to become one |
| Cross level | 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 | A line, secondary to the mainline, provided primarily for crossing or passing train, track maintenance and rail vehicles |
| 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 which when fitted over the rail will prevent unwanted rail vehicle movements by derailing those vehicles |
| 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 |
| 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 | See Check rails |
| 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. |
| 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 |
| Loop (track) | The portion of track adjacent to and connected to the mainline within a station limits. Used for trains and / or other rail vehicles to follow, cross, pass or shunt. It is primarily a running track, not an inspection siding and is not to be confused with an up or down running track |
| LWR | Long Welded Rail |
| May | Denotes an option that is permitted |
| MGT | Million Gross Tonnes |
| Mini-plug | A temporary form of rail defect removal that 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 |
| PMI | Preventative Maintenance Instruction |
| Points | See Switch |
| Rail defect | A surface or internal fault in the rail which may affect the serviceable life of the rail |
| 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 Billiton 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 |
| 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 | A section of line, other than a running line, used for shunting and the storage of rail vehicles |
| 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 |
| Switch | A switch assembly consists of either a right and left hand switch and stockrail, 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 |
| 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 |
| 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 identified by location marker boards or fixed signals |
| 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:<br>• (ABD) acoustic bearing detector;<br>• (CRD) cold rail detector;<br>• (CWD) cold wheel detector;<br>• (DED) dragging equipment detector;<br>• (HBD) hot bearing detector;<br>• (HWD) hot wheel detector;<br>• (SFD) stream flow detector; and<br>• (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:<br>(a) Switch assembly,<br>(b) 'V' Crossing,<br>(c) Checkrails,<br>(d) Closure rails,<br>(e) Bearers,<br>(f) Plates, fasteners and rail joints,<br>(g) Switch operating equipment |
| Twist | The change in the cross level between two track locations separated by a nominated distance interval |
| 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

FIGURE 4: DEFINITION OF SWITCH AND CROSSING AREAS

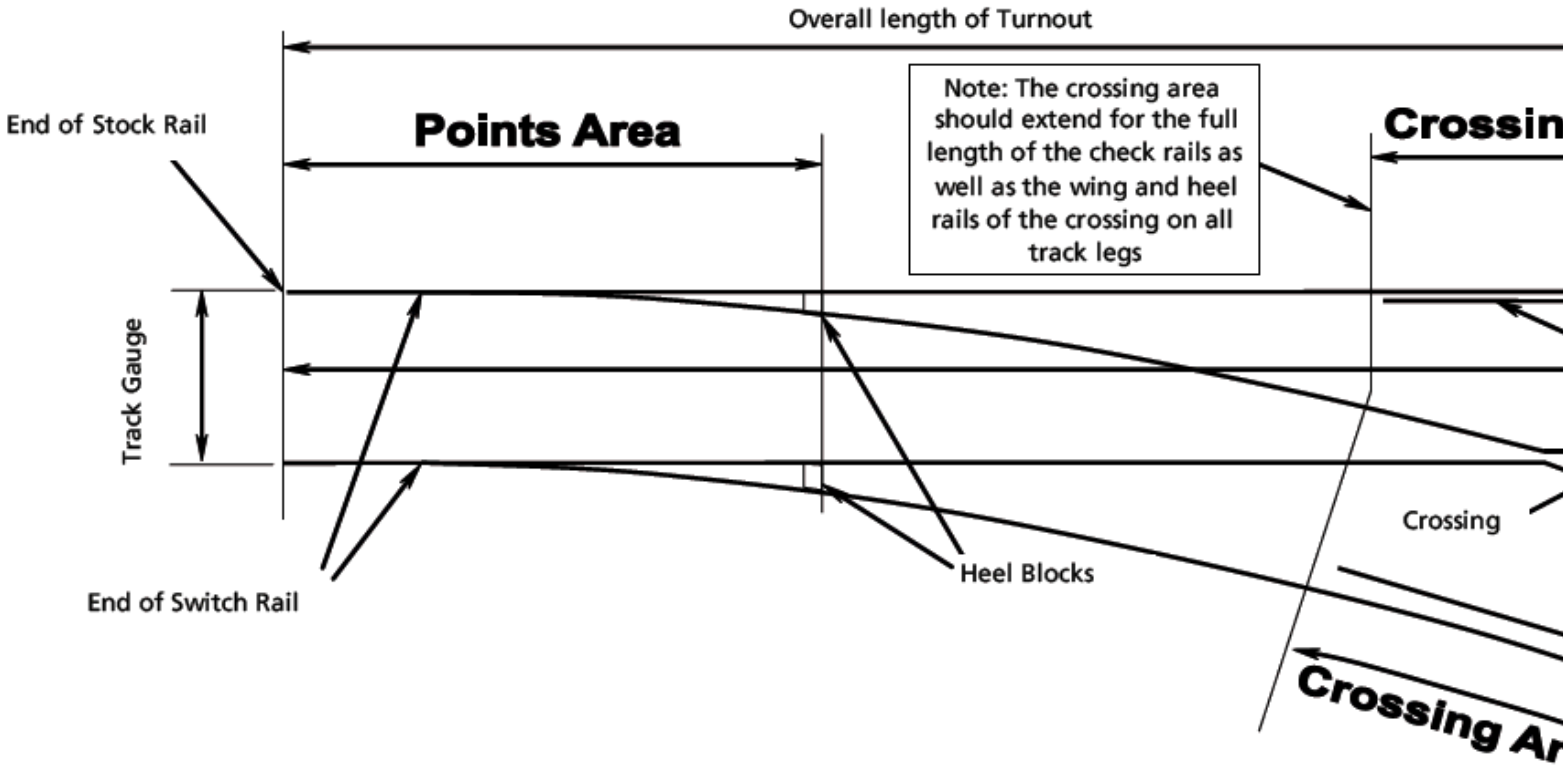
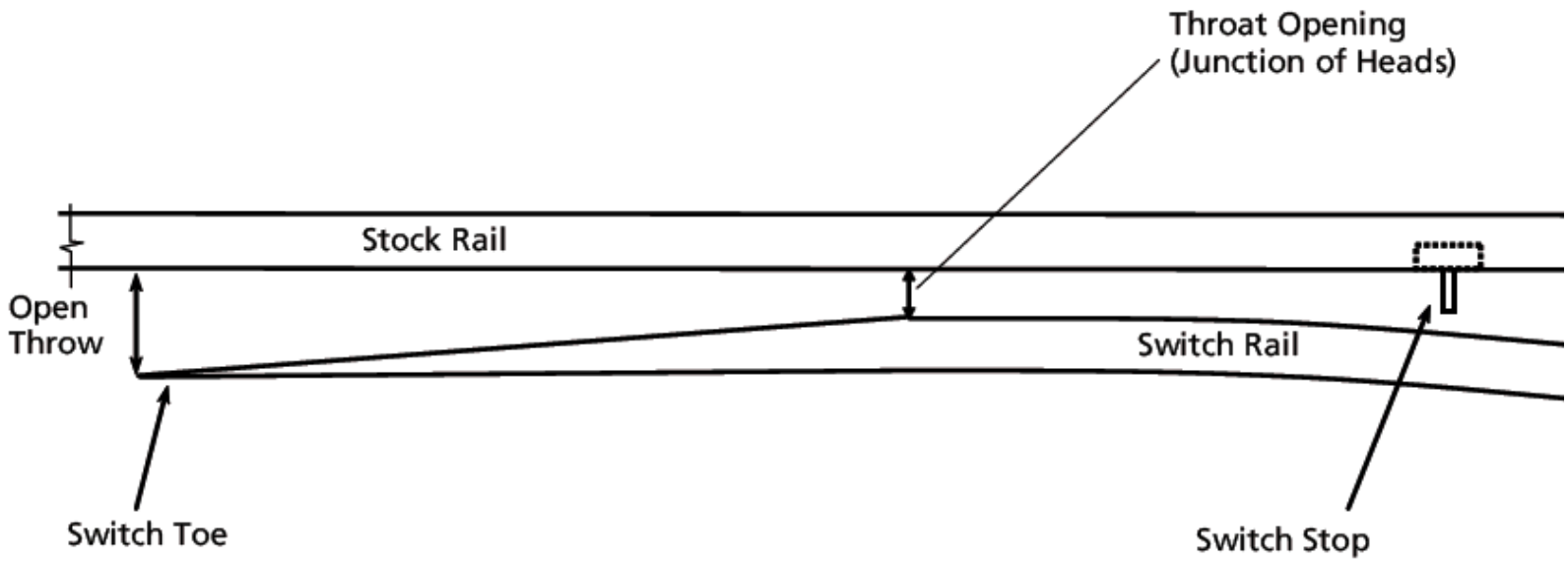
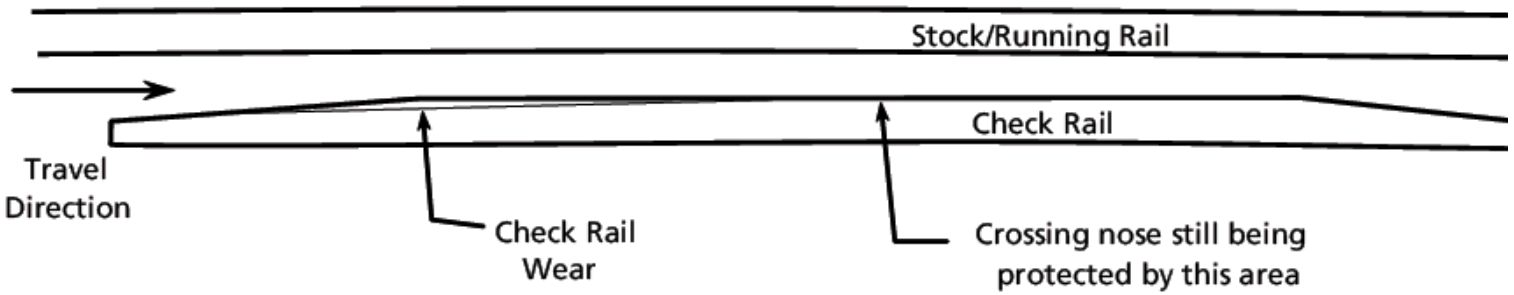


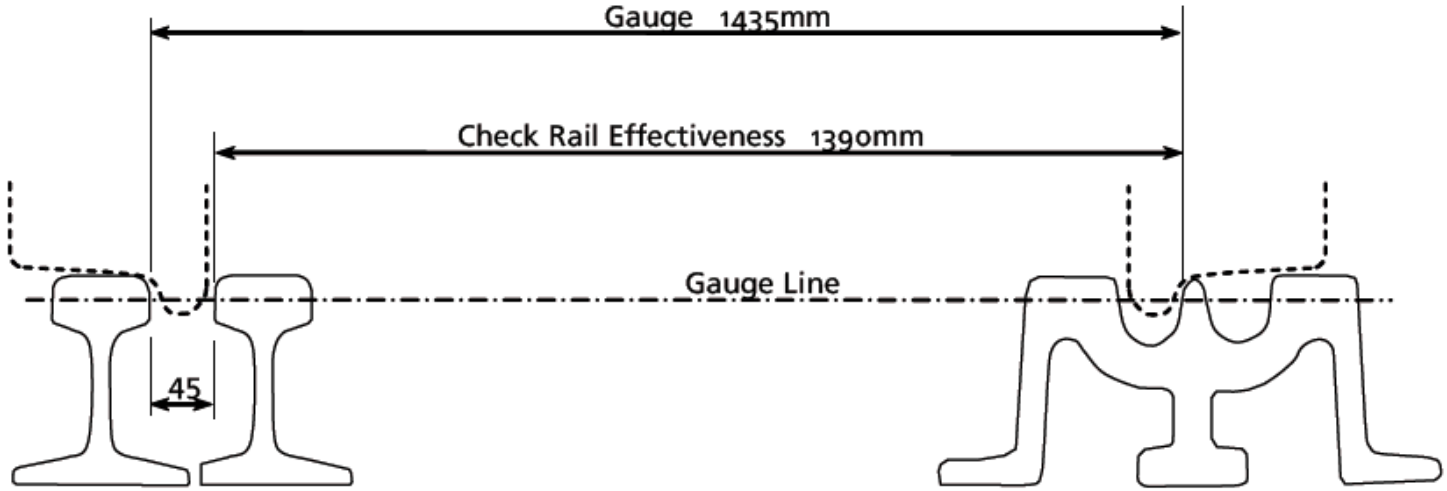
FIGURE 5: SWITCH AREA DEFINITIONS



## FIGURE 6: CHECK RAIL EFFECTIVENESS DEFINITIONS

**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.



## FIGURE 7: MEASUREMENT OF CROSSING NOSE BREAKS

**NOTE:** 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.

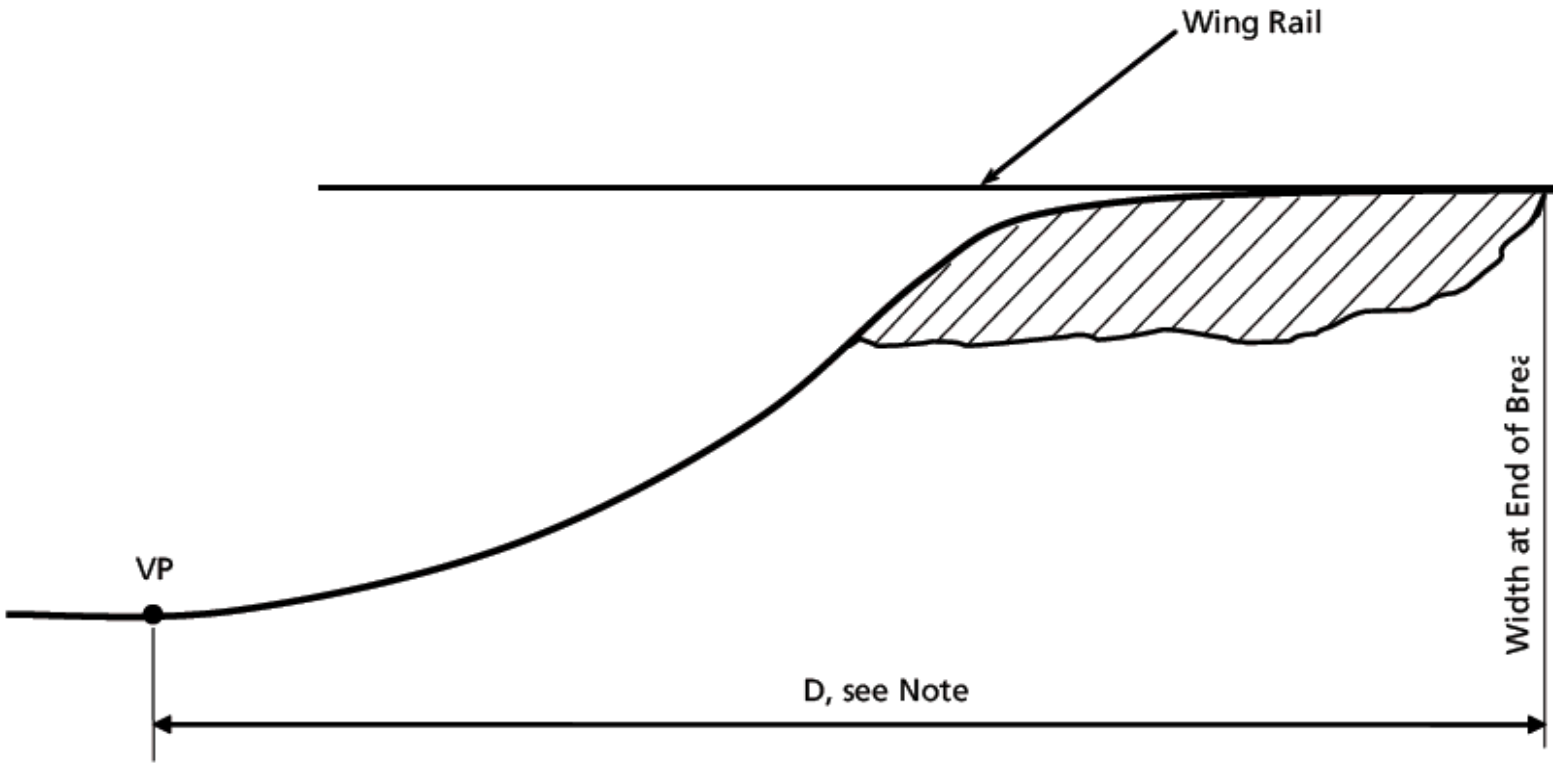


FIGURE 8: CROSSING NOSE DEFINITIONS

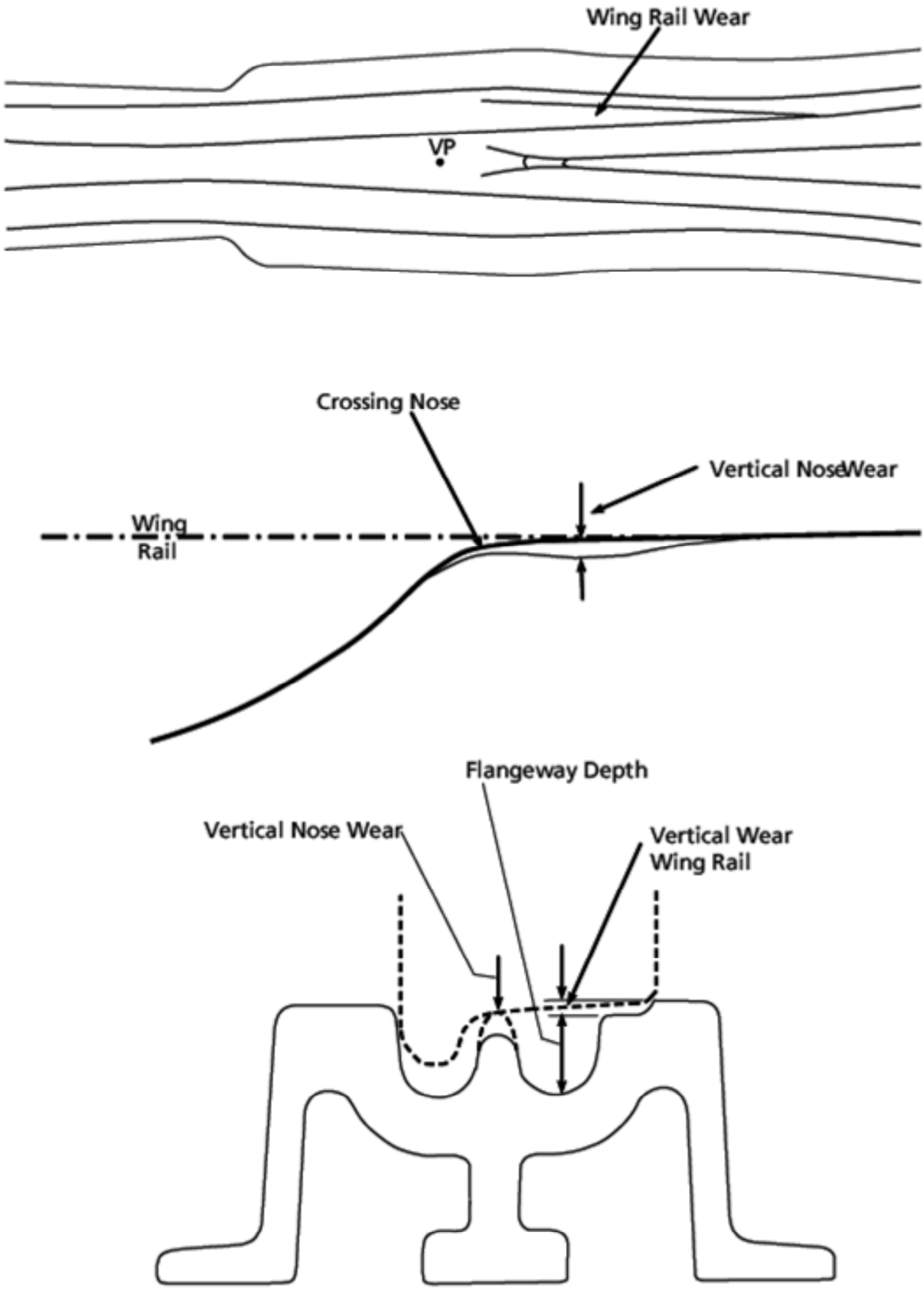


FIGURE 9: FLANGEWAY DEPTH AND CLEARANCE DEFINITIONS

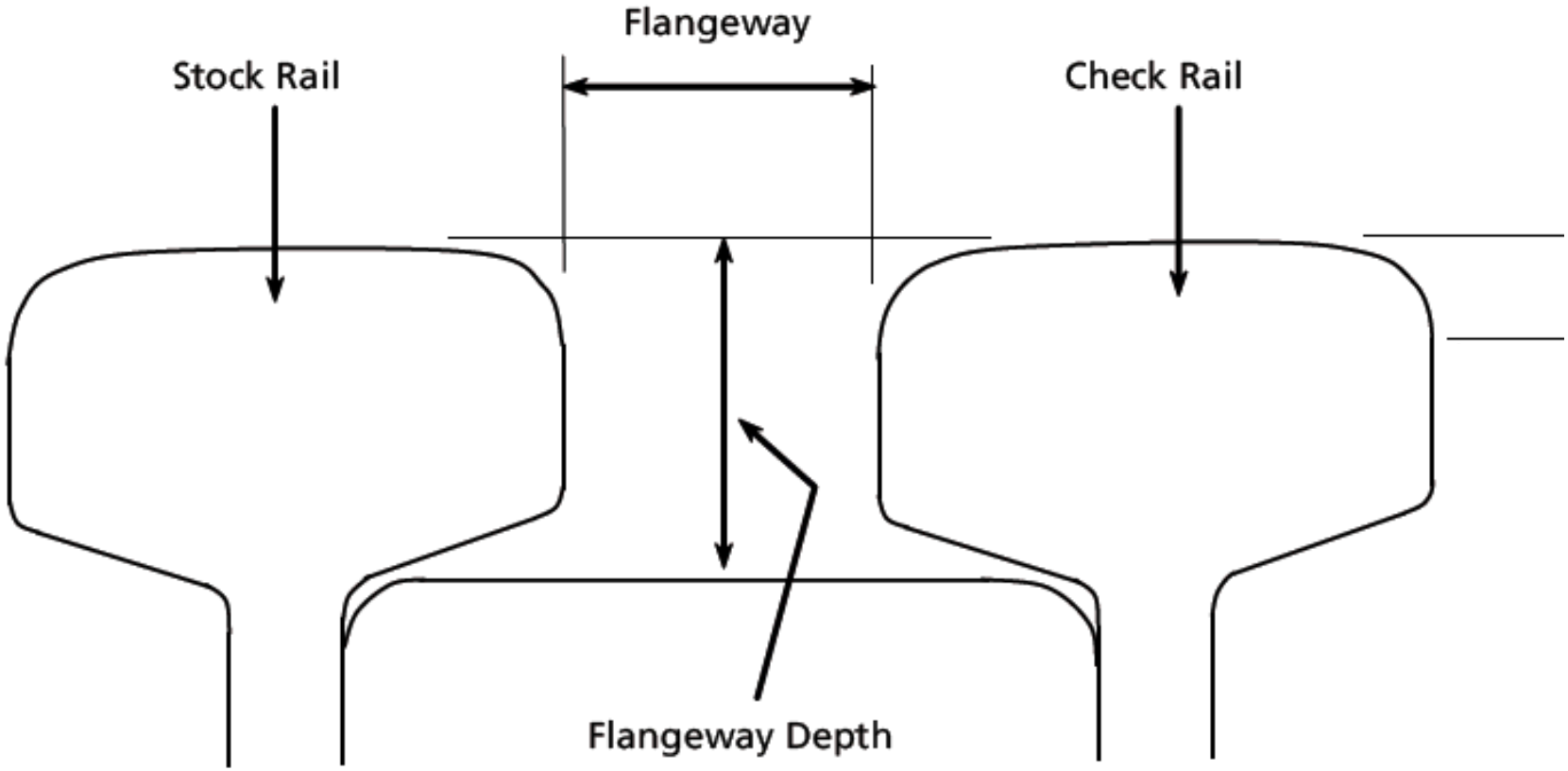
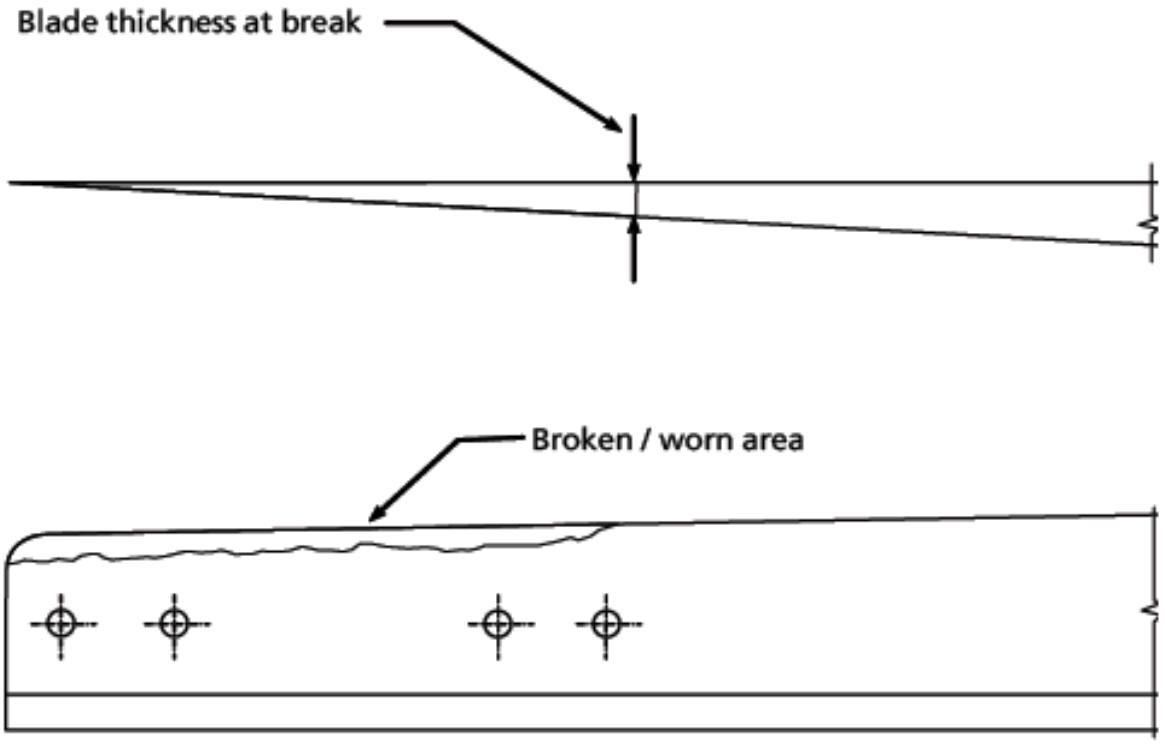


FIGURE 10: MEASUREMENT OF SWITCH BLADE BREAKS



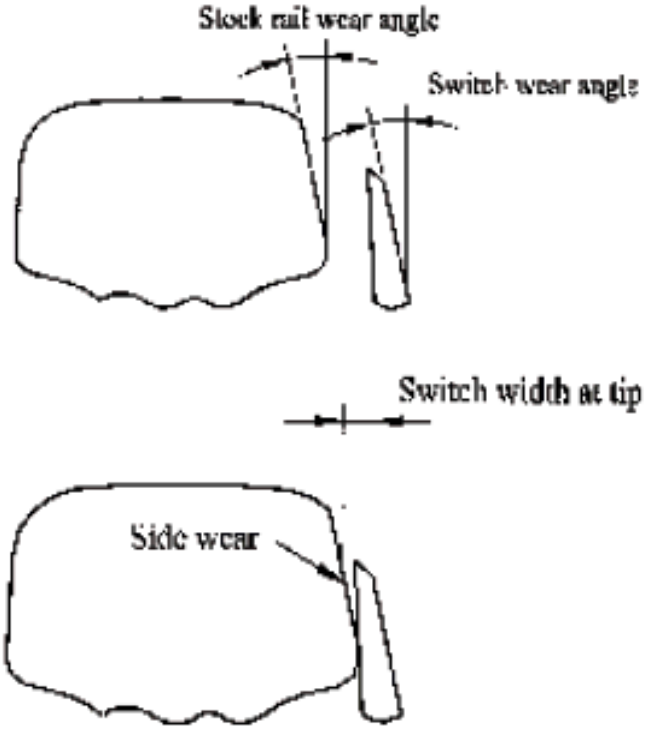
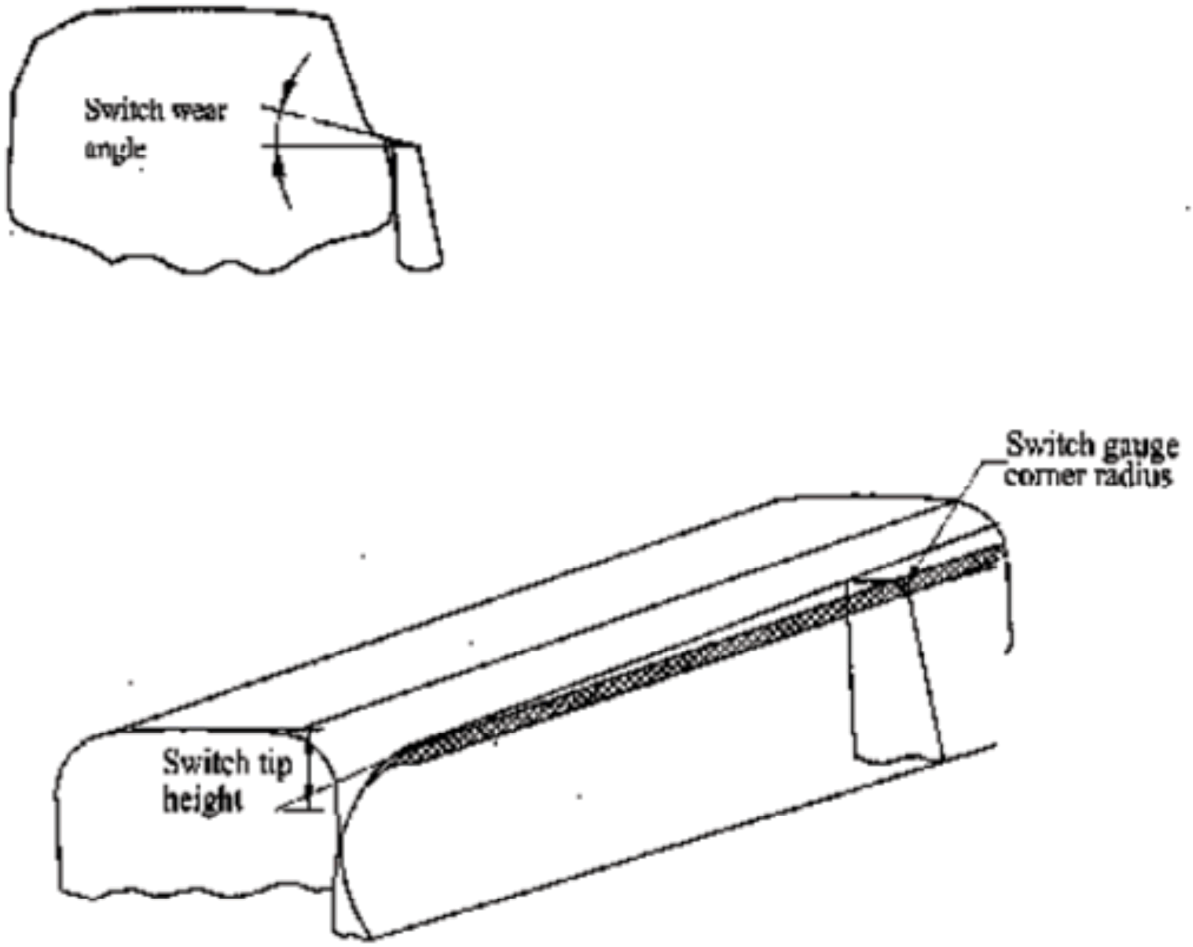



FIGURE 11: FLANGEWAY DEPTH AND CLEARANCE DEFINITIONS



# End of Document