

Non-Destructive Testing of Rail (for Internal & Surface Defects)

ETE-01-03

Applicability

ARTC Network Wide SMS

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1.0	10 Sep 08		First issue
1.1	14 Jan 09	Various	Minor editorial corrections to cross references identified following Risk & Safety Committee approval and Regulator notification
1.2	21 Jun 10	4.7 (Table 6)	Includes the option of hand testing when the signal from the zero probe is lost as per Instruction ETI-01-06 which is now withdrawn. Applicability and disclaimer updated.

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1.3	30 Jun 10	4.7 (Table 6)	Updated for clarification regarding action for complete loss of detection by zero probe - speed restriction of 40km/h has been reinstated for rail risk score 1 and note added to all rail risk scores that hand testing is acceptable.
1.4	6 Nov 12	Table 6	Revised table 6 to allow 7 days for NDT/KK Ultrasonic testers to check on rail which is untestable by the Ultrasonic Test Car, without imposing TSR. Response time to return form ETE0103-03 to Infrastructure Manager increased from 1 to 3 days, as well as minor clarifications in table regarding timing of rectification, as well as reformatting of table for ease of reading. Minor editorial changes throughout document.
1.5	21 Jan 14	3.1.1	Updated to include note that any changes to test frequency must follow ARTC Change Management Process, including notification to Regulators.
1.6	06 Oct 16	All	Remove reference to organisational structure roles. Editorial and clarifications. Rebranded.
		1.1	Remove a reference to a clause in Track and Civil CoP Rail Section 1 which refers back to this standard.
		1.3	Changes 35° to 38°c to correctly describe the angled probe.
		2.1 & 2.4	Clarity on procedure and standard for qualification. Changed superseded Australian Standard AS 3998 with AS ISO 9712.
		4.2.2	Added dimensions for the rail specific calibration block.
		4.5.1	New clause for the introductory information and added type of instrumentation.
		4.5.2	Added additional information on the capability for the specified probes.
		4.5.4	Replaced recommended with mandate to align with AS 2207.
		4.7	Updated to address squatted rail issues.
		6.2	New clause for naming system of defects.
		6.3	Added additional requirements for indications exceeding 40%.
1.7	10 Oct 17	All	Added table of figures and table of tables. Figures and tables renumbered. Editorial.
		1	Created a purpose section (1.1), scope section (1.2) and responsibility (1.4)
		3.1	Simplified heading by removing description that is part of scope
		3.1.1	Removed safety limits from the heading. Deleted reference to annual publication of the test frequency in the Technical Maintenance Plan. Added information for clarity on inspection frequency of Points and Crossings and Crossovers.
		3.1.2	Deleted
		3.3	Clarification on testing of areas of the Points and Crossings and a figure added for illustration.
		4.6	Deleted information on frequency of testing which is addressed elsewhere.
		5	Clarifying information on the programming and use of alternative NDT techniques.
1.8		7.2.1, 7.3	Updated minimum recording requirement of NDT.

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1 Introduction

1.1 Purpose

This standard sets out the requirements for non-destructive testing (NDT) of Rail for rail and welds.

This includes, but is not limited to:

- Ultrasonic Testing by:
 - Hand Held Equipment
 - Trolley
 - Rail mounted continuous ultrasonic testing equipment
- Dye Penetrant Testing
- Magnetic Particle Testing
- Visual Inspection

1.2 Scope

This standard applies to running lines and sidings where detailed inspection of rails and welds is carried out.

Where detailed inspection is not mandated, ad-hoc inspection may be directed by corridor management due to condition or operating circumstance.

1.3 Document Owner

The Manager Standards is the document owner and is the initial point of contact for all queries relating to this Standard.

1.4 Responsibilities

The authority with the overall responsibility for the delivery of safe and reliable track and civil infrastructure for the business unit or their delegate is responsible for the implementation of this standard.

1.5 Related documents

This standard should be read in conjunction with;

- ARTC Track & Civil Code of Practice (T&C CoP) Section 1: Rail and related standards
- AS 1085.20 Railway track material – Welding of steel rail
- 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
- ETN-01-04 Manual for Non-Destructive Testing of Rail
- ETP-00-01 Written Practice for the Training, Competency Assessment and Certification of Personnel in Non-Destructive Testing to American Society of NDT's: SNT-TC-1A (2001 Edition)

- AS ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel.

1.6 Limitations of this Standard:

It is recognised that NDT is not 'infallible'.

There are a number of limitations of existing ultrasonic techniques:

- Some defects can lie in zones of the rail that are not tested ultrasonically: in particular the foot of the rail
- There is no positive (failsafe) feedback to confirm that the angled probes (70° and 38°) have continuous contact with the rail
- There is no positive (failsafe) feedback to confirm that the angled probes (70° and 38°) are penetrating the depth of the rail
- AS 2207 recommends that probes with incident angles greater than 20° to the major expected reflecting surface should not be used.

2 Personnel Qualifications

2.1 Non-Destructive Testing Qualifications

NDT shall only be carried out by personnel who have been assessed as competent in accordance to ETP-00-01 Written Practice for the Training, Competency Assessment and Certification of Personnel in Non-Destructive Testing to American Society of NDT's: SNT-TC-1A (2001 Edition) or AS ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel.

Testing methods are as described in ETN-01-04 Manual for Non-Destructive Testing of Rail or as approved by Manager Standards.

2.2 Visual Capability

All Ultrasonic testers must be able to:

- Read a Jaeger Number 1 Chart at a distance of not less than 305mm
- Be capable of distinguishing and differentiating contrast between colours and shades of grey used in the method.

All Ultrasonic testers shall carry out a visual check annually.

Note: These competencies are in addition to other ARTC requirements for items such as Safeworking, medical requirements, etc.

2.3 Records

Records shall be kept with respect to each certification of:

- Name of certified employee
- Level of certification method
- Procedures in which they have been assessed as competent
- Examination results
- Competency assessment tool
- Dates of certification
- Signature of Employer's Representative.

2.4 Re-Certification

Shall be in accordance to ETP-00-01 Written Practice for the Training, Competency Assessment and Certification of Personnel in Non-Destructive Testing to American Society of NDT's: SNT-TC-1A (2001 Edition) or AS ISO 9712 Non-destructive testing – Qualification and certification of NDT personnel.

3 Non-Destructive Testing Requirements

3.1 Existing Rail and Welds

3.1.1 Testing Frequency

Internal and rail surface condition shall be tested at a frequency that maintains combined rail and weld breaks at or below 0.02 breaks per km per year. Rail break averages shall be calculated over a sufficient number of kilometres and years to demonstrate trends and rail break concentrations. Guidance on the testing frequency is provided in ETN-01-04 Manual for Non-Destructive Testing of Rail. Test frequency for each line section shall be published in the Technical Maintenance Plan.

The through and diverging legs of Points and Crossings should be inspected as per the frequency of the track they connect. Where they connect to non- ARTC tracks the inspection should be based on the risk to ARTC.

All crossovers connected to tracks that are tested shall be identified. Where it is not practical to schedule testing of crossovers by rail mounted continuous ultrasonic testing equipment alternate methods should be considered, for example use of hand held equipment for testable areas. For untestable areas of the crossovers, treat as per section 3.3. The test frequency for crossovers should be at a frequency of 15 MGT during the service life of the rail or as specified otherwise by ARTC e.g. in an approved Technical Maintenance Plan with consideration of the broken rail rate per kilometre.

Rail may be tested more frequently or less frequently at the discretion of the relevant ARTC authority.

Note: Any changes to test frequency must follow the ARTC Change Management Process, including notification to Regulators.

When proposing to vary established testing intervals, the proposing officer must document the basis for the change. The recommended maximum adjustment to the testing frequency at any one time shall be:

- In the case of a shorter interval: the new testing interval shall not be shorter than $\frac{1}{3}$ of the previous interval
- In the case of a longer interval: the new testing interval shall not be longer than $1\frac{1}{2}$ times the previous interval.

The main factors to consider when proposing a change to test frequency are:

- Broken rail rate per kilometre
- Broken Rails as a % of the Total defect rate per kilometre
- Presence of high risk locations.

The main factors to consider when seeking to reduce the number of defects:

- Ambient temperature differential and neutral temperature
- Curvature
- Rail section
- Rail head wear
- Axle loads.

3.2 NDT of New Welds (Aluminothermic, Wire Feed (Fluxcore) and Flashbutts)

3.2.1 General

All new welds shall be tested. Testing shall include visual inspection, ultrasonic inspection and geometric inspections (see below). Testing shall be carried out:

For all tracks no sooner than 5 hours after grinding (and where practicable
24 hours after grinding)

Tracks rated \geq 30 tonne axle load not later than 14 days of being installed.

Tracks rated $<$ 30 tonne axle load not later than 3 months of being installed.

3.2.2 Ultrasonic Inspection of Welds

The ultrasonic test shall be carried out in accordance with the methods contained in ETN-01-04 Manual for Non-Destructive Testing of Rail.

3.2.3 Visual Inspection of Welds

The visual inspection shall be carried out in accordance with Appendix E "Visual Inspection and Alignment" of AS 1085.20 Railway Track Material – Welding of Steel Rails and relevant ARTC standards.

3.2.4 Geometric Inspection of Welds

The ultrasonic inspector shall carry out an inspection of the Weld Geometry in accordance with ETM-01-01 Rail Weld Geometry Standard.

3.2.5 Inspection of Punch Marks

Where welding has been carried out as part of a restressing of the rails the ultrasonic inspector shall examine the punch marks on the rail. A measurement is to be taken of the length between punch marks and recorded on the Welders' Return Form.

3.3 Points and Crossings

Areas which cannot be tested effectively Figure 3-1 by either the rail mounted continuous ultrasonic testing equipment or hand held ultrasonic equipment include: the narrow section of switch blades, manganese crossing components, and the rail foot. These areas should be visually inspected by a competent rail safety worker; this can be done during Track Patrol, General or Detailed Points and Crossings inspections.

Housed points missed by the rail mounted continuous ultrasonic testing equipment (as it may need to lift probes to avoid damage) should be tested by hand held equipment.

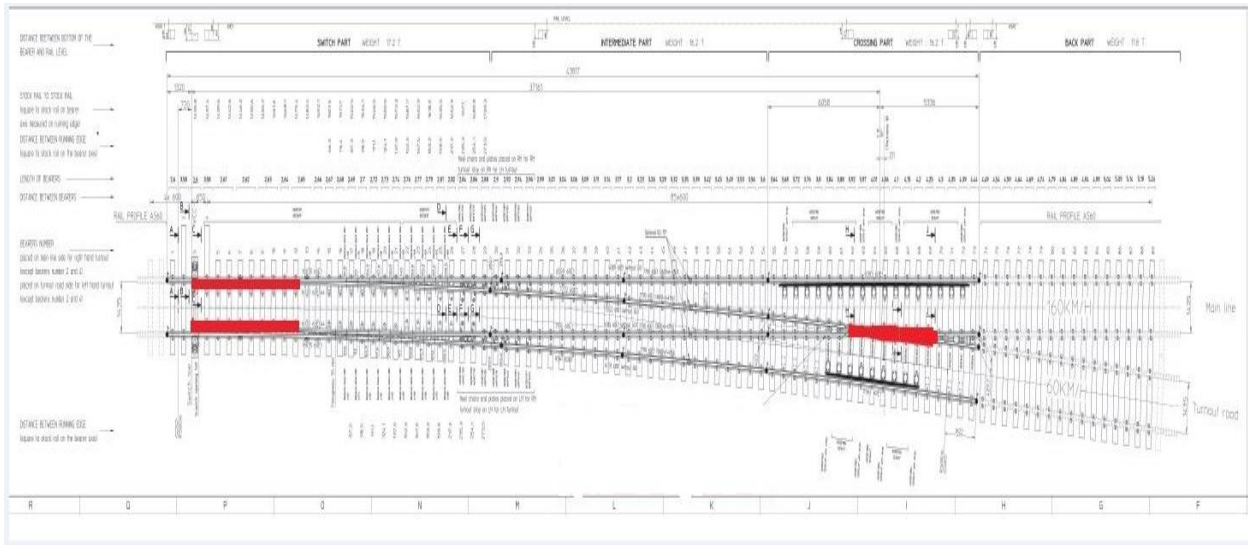


Figure 3-1: Untestable areas of the Points and Crossings

4 Ultrasonic Testing

4.1 General Guidance to Ultrasonic Testing Philosophy

The following sections are intended to standardise the existing technologies to enable consistency amongst the various testers. It is NOT intended to limit the innovation and development of new techniques or equipment. ARTC recognises the limitations of current techniques and actively encourages any improvement to testing capabilities. Where variance to the following standard is required, an application for a waiver should be sought from the Manager Standards.

4.2 Calibration Process

All ultrasonic equipment shall be re-calibrated within the intervals specified in Section 4.2.1. Calibration test methods shall be carried out in accordance with the requirements of AS 2083 and as detailed in ETN-01-04 Manual for Non-Destructive Testing of Rail.

4.2.1 Calibration and Equipment Inspection Periods

Instrument Features	Recording Intervals	Documentation Requirements
Vertical linearity	12 monthly	Yes
Horizontal linearity	12 monthly	Yes
Probe shoe condition	Daily	Not Required
Angle beam probe index point	Daily	Yes
Angle beam probe beam angle	Daily	Yes
All probe gain reserve (OSG) >20dB,	12 monthly	Yes
Calibration Blocks	2 Yearly	Yes
Pulse Count (Machine only)	Daily	Yes

Table 4-1: Calibration Schedule for Ultrasonic Testing Equipment

4.2.2 Calibration Blocks

The following blocks shall be used for calibrating the hand held ultrasonic equipment:

- Block V1 (from AS 2083)
- Block V2 (from AS 2083) may also be used for field calibration
- Rail Specific Gain Calibration Block Figure 4-1. This block is 250mm x 75mm x 25mm with a 1.5mm side-drilled hole (SDH) 50mm from the top surface and 50mm from one end.

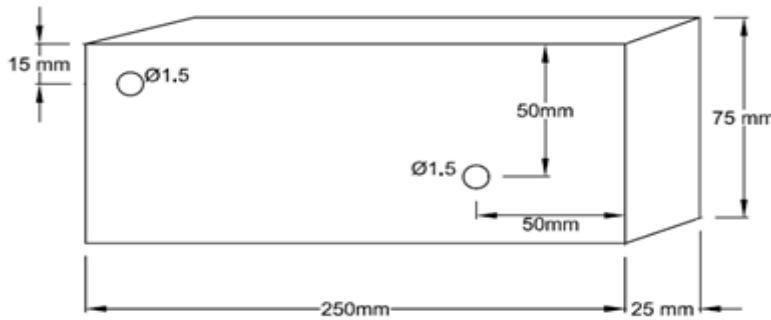


Figure 4-1: Rail Specific Gain Calibration Block

Note: New modified blocks now have an additional 1.5mm hole drilled across the block at a depth of 15mm.

4.2.3 Calibration Settings for Hand Test Probes

Hand testing probes shall be calibrated for range and sensitivity as shown in Table 4-2.

Probe	Angle	Frequency	Range Calibration	Sensitivity Calibration
Probe 1 Single 70°	70°	2MHz	Normal Rail tests 0-200mm Bolt hole Tests 0-250mm	80% FSH from a 1.5mm SDH @ 25mm depth, plus 6dB for scanning
Probe 2 38°	38°	2MHz	0-250mm	80% FSH from a 1.5mm SDH @ 50mm depth, plus 6dB for scanning
Probe 3 Single 0°	0°	2MHz	0-200mm	80% FSH from a 1.5mm SDH @ 50mm depth, plus 6dB for scanning
Probe 4 Twin 0°	0°	2MHz	0-200mm	80% FSH from a 1.5mm SDH @ 50mm depth, plus 6dB for scanning
Probe 5 Small 0°	0°	4MHz miniature	0-100mm	80% FSH from a 1.5mm SDH @ 50mm depth, plus 6dB for scanning
Probe 6 Single 70°	70°	4-5MHz	0-100mm	80% FSH from a 1.5mm SDH @ 15mm depth of V1 block, plus 6dB for scanning
Alternative Probe 6 Twin 70°	70°	4-5MHz twin	0-100mm	80% FSH from a 1.5mm SDH @ 25mm depth, plus 6dB for scanning

Table 4-2: Calibration Settings

Note: FSH = Full Screen Height SDH = Side Drilled Hole

4.2.4 Continuous Test Car Calibration

The continuous test car is required to calibrate the machine on a daily basis. The exact method of calibration shall be agreed between the contractor and ARTC representative. It could include:

- Technical measurement of the machine’s testing equipment as detailed in ETN-01-04 Manual for Non-Destructive Testing of Rail

- Recorded comparison of car measurements against the hand testing sizes (hand held equipment having been calibrated in accordance with section 4.2 of this document)
- Checks of defect identifications against known sections of defects.

It is recommended that auditing checks are periodically carried out on the performance of the car through the use of an undisclosed test track.

4.2.5 Pre-test Checks

In addition to calibration checks, all equipment should have pre-test checks as appropriate to its use.

4.3 Environmental Requirements

4.3.1 Ambient Temperature

Continuous Rail Testing should not be programmed to be ultrasonically tested at times where rail temperature is likely to exceed 50°.

Where possible, the Continuous Rail Testing should be programmed at times when the rail temperature is likely to be below the Stress Free Temperature (SFT) of the Rail.

Where the rail is programmed to be tested once or twice a year, the test should not be programmed during the summer months.

4.4 Equipment Requirements

All ultrasonic testing equipment shall have sufficient resolution, sensitivity and accuracy to be capable of identifying and recording the following minimum defect sizes:

- Transverse defect in weld 10mm height
- Transverse defect in rail 5mm height
- Longitudinal defect 10mm length
- Bolt hole cracks >10mm oblique length
- Multiple transverse defects: identify separate defects of 20mm separation.

4.4.1 Resolution

The equipment should be capable of readily resolving adjacent reflectors with a separation along the beam axis of 2.5 wavelengths. The resolution requirements are shown in Table 4-3:

Nominal Frequency (MHz)	Compression Wave Probes (mm)	Shear Wave Probes (mm)
2.0	7.4	4.1
2.5	5.9	3.3
4.0	3.7	2.0

Table 4-3: Resolution requirements

4.5 Equipment Technical Specifications

4.5.1 General

The ultrasonic testing equipment shall employ A-scan presentation and shall have a reserve sensitivity of at least 20dB at the maximum beam path used. The equipment and probes shall be capable of operation within a frequency range of 2MHz to 6MHz.

Instrumentation may be digital or analogue. Digital units may have calibrations stored in the database and recalled as needed, in which case the calibration should be checked before use. The frequency at which these calibrations need to be documented is set out in ETN-01-04 Manual for Non-Destructive Testing of Rail.

The use of other equipment types will be considered if the user can demonstrate, using known defects, that the equipment is at least as efficient at detecting internal defects as the above equipment.

4.5.2 Hand Held Ultrasonic Equipment

The ultrasonic probes in Table 4-4 are the specified minimum for hand testing in ARTC. The ultrasonic inspector should carry all six probes.

Name	Shape & Size	Measurement Angle	Frequency
Probe 1 Single 70°	'14x14'mm to '20x22'mm	70° ±2°	2.0 – 2.5 MHz
Probe 2 38°	'14x14'mm to '20x22'mm	38° ±2°	2.0 – 2.5 MHz
Probe 3 Single 0°	24mm diameter	0° ±2°	2.0 – 2.5 MHz
Probe 4² Twin Crystal 0°	7x18mm	0° ±2°	2.0 - 2.5 MHz
Probe 5 Small 0°	10mm diameter	0° ±2°	4.0 – 5.0 MHz
Probe 6 Single Crystal 70° or Twin Crystal 70°	'10 x 10'mm or 3.5 x 10mm	70° ±2°	4.0 - 5.0 MHz

Table 4-4: Ultrasonic Probes for Hand Held Rail Testing ^{1,3}

Note:

- 1 *These probes are specified to standardise current probe usage: refer to section 4.1 of this document for the introduction of other equipment.*
- 2 *Probe 4 is an alternative to Probe 3*
- 3 *The Probes specified are the minimum requirements for general testing of rail and welds. Other probes maybe used to target other areas or specific rail defects.*

70° Probe: *This probe is used to ultrasonically examine the railhead area for defects of a transverse nature only, including weld defects. All probing with a 70° probe should be done in both testing directions. 70° probes were originally chosen for use in uni-directional track where transverse defects (TDs) tend to occur at 18 - 22°. However with*

bi-directional track the TDs can be more vertical and do not always reflect the 70°

38° Probe: *Defects located by this probe include bolt hole cracks and defects of a transverse nature in the web and flange (section below the web only). All probing with a 38° probe should be done in both testing directions from the running surface of the rail.*

0° Probe: *This probe is used to ultrasonically examine the full rail depth. Defects located by this probe include bolt hole cracks and longitudinal defects of a vertical or horizontal nature in the head, web and flange (in the section below the web only).*

4.5.3 Rail Mounted Continuous Ultrasonic Testing Equipment

An audible alarm shall be fitted to the 0° ultrasonic probe to indicate ‘loss of bottom’ over any length greater than 10mm.

The minimum specified probes for continuous ultrasonic testing equipment in ARTC are shown in Table 4-5.

Name	Measurement Angle	Signal Frequency
Probe 1 Forward and rear facing 70°	70° ±2°	2.0 – 2.5 MHz
Probe 2 Forward and rear facing 38°	38° ±2°	2.0 – 2.5 MHz
Probe 3 Single 0°	0° ±2°	2.0 – 2.5 MHz

Table 4-5: Minimum Ultrasonic Probes for Continuous Rail Testing

Note:

- 1 *The Probes specified are the minimum requirements for continuous testing of rail and welds. Other probes maybe used to target other areas or specific rail defects.*
- 2 *Use of a 45° probe in place of the 38° probe may be considered in conjunction with the relevant ARTC representative.*

4.5.4 Couplant

For normal rail testing, water will be used as a couplant. This can be thickened with methyl-cellulose (e.g. wall paper paste) if necessary. A detergent (i.e. dish washing liquid or truck wash) can be added to the water as a wetting agent.

However, water SHOULD NOT be used if the rail temperature is below 0° C unless the operator is satisfied that an antifreeze additive has been added to enable the correct testing procedure.

Oil may be used as a couplant on calibration blocks.

AS 2207 mandates that couplants used in calibration are the same as those used during testing.

In exceptional circumstances diesel may be used as a couplant over short distances. Care should be taken to minimise the amount used and to record the location.

4.6 Continuous Ultrasonic Testing

Continuous ultrasonic testing shall be carried out on a face. The continuous testing contractor shall demonstrate that they have detected at least 65% of all defects listed as reportable in ARTC T&C CoP Section 1: Rail and related rail defect standards.

All anomalous indications found during the Continuous ultrasonic testing shall be evaluated manually.

The continuous ultrasonic testing car is required to record the rail temperature. At least two temperature readings should be taken daily to capture the maximum and minimum temperatures.

4.6.1 Management of Human Factors

The testing process, and in particular the conditions in the car vehicle should be optimised to facilitate the concentration of the operator on the data being analysed and to minimise the risk of a missed defect. This includes:

- The judicious use of post analysis facilities of recorded data
- In-car working conditions and temperature
- Computer screens that are adequately protected from sun glare
- Monitoring that the speed of the car is compatible with the ability to analyse data presented
- Safeworking practices are adequately catered for outside the time allowed for test analysis
- Fatigue management of operators (consideration of rotation of operators with hand testers)
- Undue pressure on time allowed in section
- Peer development and regular training in compliance with this document
- Monitoring of operators' performance in terms of % of defect identified.

4.7 Assessment Required of any Ultrasonic Shielding

This section describes how to assess and respond to levels of ultrasonic shielding and the testability of rail. It does not describe how to test rail for internal rail defects.

During ultrasonic testing there shall be continuous monitoring of positive indications of normal test procedure, e.g. continuous back wall echo as per section 4.5.2, grain structure, heat affected zone etc.).

Shielding can be caused in a number of ways. Examples are:

- Excessive grease on the rail head
- Gauge corner cracking
- Rolling contact fatigue on the rail head
- Badly pitted rail at, for example, a level crossing
- Dirt and debris on the rail head
- Squats defined as horizontal lamination within 10 mm of the running surface
- Other causes that disrupt ultrasonic inspection

These conditions can cause a loss of back wall echo (LBWE)

Levels of shielding, actions and response times are given in Table 4-6. For the purposes of this table:

- Actions shall progress down the table within the response times set, to the worst applicable level of shielding
- Loss of back wall echo (LBWE) as expected at bolt holes, turnout components, etc shall be disregarded provided there are no adverse indications
- Shielding and untestable rail is to be reported to the relevant ARTC authority and recorded according to requirements set out in section 7.3. The reports are to be entered into the defect database

Shielding level	Purpose of assessment	Definition	Response time(s)	Action(s) if shielding or untestable
Minor	Require the test car to re-test at low speed if difficult to test.	Any of the following with the test car testing at normal speed: <ul style="list-style-type: none"> gain had to be turned up, vehicle had to reduce speed, LBWE for a length greater than 50mm, more than one patch of LBWE per metre, if the rail is generally difficult to test, or operator suspects that one or more probes are not giving valid results. 	Immediately	The test car is to stop. Track should be examined to identify cause of loss of detection. Rail shall be cleaned as necessary and re-tested at 5km/h with additional couplant if necessary.
			7 days	Test car shall report shielding.
Moderate	Report the early stages of deterioration so remediation can be planned.	Any of the following with the test car testing at reduced speed: <ul style="list-style-type: none"> LBWE for a length between 50 and 200mm, if the rail is generally difficult to test, operator suspects that one or more probes are not giving valid results. 	3 days	Test car shall report shielding. Rectification to occur within timeframes determined in Corridor Management Plans.
Major	Require hand testing if the car cannot test.	Any of the following with the test car testing at reduced speed: <ul style="list-style-type: none"> LBWE for a length greater than 200mm along the rail, more than one patch of LBWE per metre, one or more probes are giving inconsistent results, unable to size a defect identified previously. 	7 days	Test affected rail by hand or apply TSR as per Table 4-7.
			1 day	Test car shall report shielding.
Untestable	Protect against the risk of unfound defects. May leave some low-risk situations without protection.	Any of the following when testing rail by hand: <ul style="list-style-type: none"> LBWE for a length greater than 200mm along the rail, more than one patch of LBWE per metre with each patch longer than 150mm, one or more probes are giving inconsistent results for a length greater than 200mm, unable to size a defect identified previously, For squatted rail, if there is less than 60mm of sound rail between squats, thereby preventing the 70° probe from detecting a transverse defect under either squat. 	1 day	Apply TSR as per Table 4-7 until works are performed to restore testability and the rail is tested successfully. Hand tester shall report test result.

Table 4-6: Assessment of shielding, response times and actions

If any of the conditions in a row apply, then TSR for that row is to be imposed					
TSR speed	Passenger Traffic	Annual MGT	Rail size	Head wear	Number of breaks /km
40 km/h	More than once a day	50+	Less than or equal 80 lb (40Kg)	>30%	>0.02 broken rails per km/pa
80 km/h	Once a day or less	15 to 50	81lb to 59Kg	15% - 30%	0.015 to 0.02 Broken rails per km/pa
If required	None	<15	60 kg or greater	<15%	< 0.015 Broken Rails per km/pa

Table 4-7: TSR Speeds According to Rail Risk Score. The criterion in the column giving the lowest speed TSR applies

5 Alternative Non-Destructive Testing Techniques

Alternative Non-Destructive Testing techniques for example dye penetrant testing and magnetic particle testing are not required to be programmed on a cyclic basis, but can be used as a means of detecting, confirming or sizing rail cracks with or without ultrasonic testing as required.

Where alternative methods are used, equipment and products should comply with the relevant Australian Standard. Personnel shall complete specialist training in all NDT Testing techniques and shall be certified for each technique.

All testing methods and frequencies shall ensure that the broken rail risk profile is not compromised.

6 Classifying and Sizing Defects

6.1 Classifying Defects

All weld geometry defects should be classified in accordance with ETM-01-01 Rail Weld Geometry Standard.

All rail and weld internal and surface defects should be classified in accordance with ARTC T&C CoP and related standards.

6.2 Naming System of Defects (Nomenclature)

Defects which can be identified using non-destructive testing are illustrated in Figure 6-1.

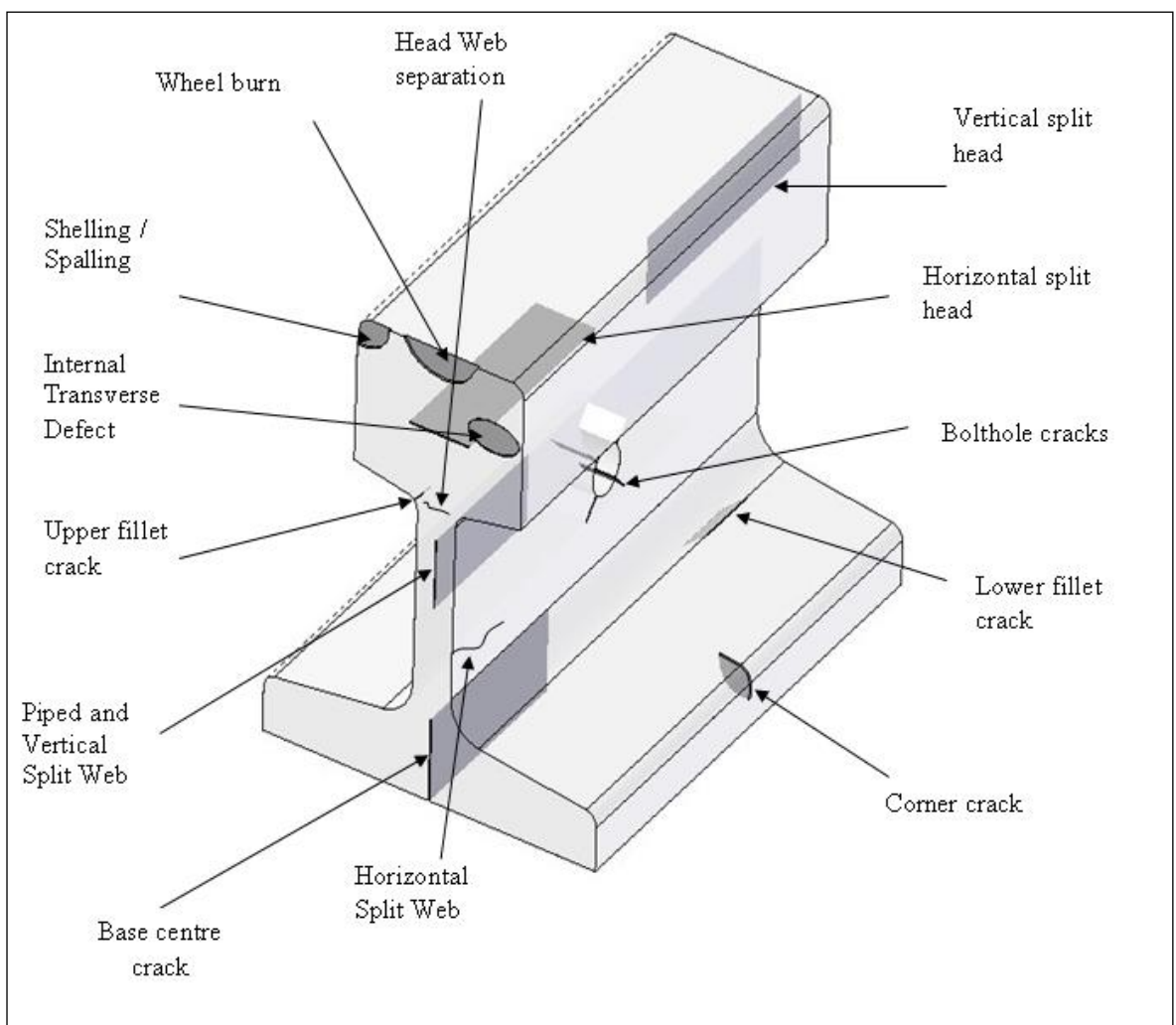


Figure 6-1: Internal rail defects definitions

6.3 Sizing Defects

All indications exceeding 40% of full screen height at **evaluation sensitivity** shall be measured for precise size. All defects shall be recorded in mm. See Section 7 for reporting requirements.

All defect sizing should be determined by using the “last significant echo” method. Any loss of back wall echo or other known reflectors (during hand test sizing) shall be investigated by visual inspection and scanning from the other faces of the rail.

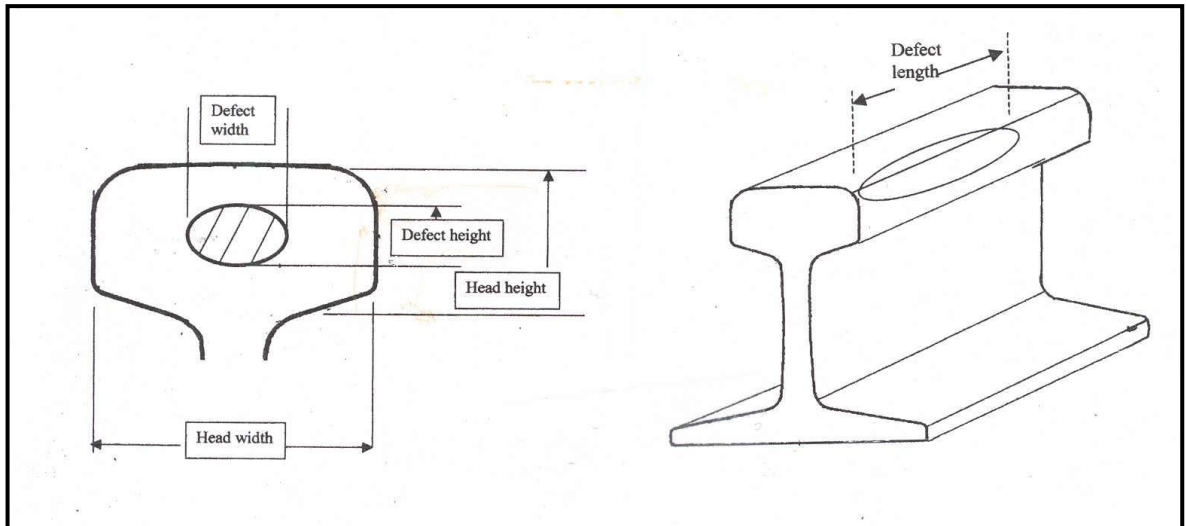


Figure 6-2: Definition of Defect Dimensions

All indications exceeding 40% of full screen height at evaluation sensitivity shall be evaluated for size. Sizing should be done by the last significant echo method.

7 Recording and Reporting Requirements for Rails and Welds

7.1 Format of Reports

Electronic Record keeping is recommended. Where electronic means are used a daily back-up must be made.

Where paper based systems are preferred ARTC has published forms that may be used. These forms are not mandatory; the collection of the information can be done on other forms or in an electronic spreadsheet. Inspection reports need to contain the listed reportable data of sections 7.2, 7.3 & 7.4, regardless of the format used.

7.2 Inspection Report

Every ultrasonic test and weld geometry test undertaken shall be recorded. Form *ETE0103F-01* Record and Report of Ultrasonic Test may be used. Any defects found should be reported as per section 7.2.3 Defect Reports.

A record of every ultrasonic test shall be kept. The report shall be kept even if no defect is found; or if defect found is small and is not referred to as 'reportable' or 'to be monitored' in the defect standards.

7.2.1 Ultrasonic Test Records

The ultrasonic test records should record (as a minimum):

- Date
- Location of test
- Name of the operator
- Ultrasonic flaw detector (type, serial No)
- Probes used (type, serial No)
- Couplant used
- Reference to this procedure
- Test results
- Any variations from the requirements of this procedure
- Any test restrictions
- Rail temperature:
 - Hand Testing
 - Continuous Car Testing: At least two temperature readings daily to capture the Maximum and minimum temperature
- Any additional tests (dye penetrant etc.) and results

These records may be kept electronically or using paper based forms such as *ETE0103F-01* Record and Report of Ultrasonic Test.

7.2.2 Weld Test Records

A record of every Weld Test shall be kept. In addition to the requirements of 7.2.1, the Weld Test report shall include:

- the weld number
- date of test
- location of weld
- result of visual inspection
- result of ultrasonic inspection
- result of geometric inspection.

These records may be kept electronically or using paper based forms.

7.2.3 Defect Reports

All sizable rail or weld, internal or surface defects, or any weld geometry defect, shall be reported. Form ETE0103F-02 Rail Flaw Report may be used. This is to provide a record where a defect is found or if the geometry of a new weld is found to be substandard. This can be on an individual form, however when the continuous ultrasonic testing is carried out it is more likely to be stored in a spreadsheet.

In addition to the requirements of 7.2.1, the Defect report shall include as a minimum:

- Location of defect (within 5m accuracy)
- If a weld - the weld number
- If in a turnout – the turnout number
- Date of test
- Type of defect
- Size of defect
- Tests carried out & results
- Any action already applied (e.g. speed restriction, defect plated etc.)
- Rail specification (e.g. rail size, presence of rail wear, SC or HH etc.)

These records will be kept electronically in the relevant Asset Management System.

Note *ARTC Rail Defects Handbook gives more detail and information on the various defect modes.*

7.3 Shielding Reports

Any areas of ultrasonic 'shielding' found using the ultrasonic testing car shall be reported. Form ETE0103F-03 Rail Surface Condition Report may be used. The report may be paper based or recorded as an electronic database.

The report should record as a minimum:

- Date
- Location of test
- Degree of difficulty in measurement
- Suspected reason for shielding (Gauge corner cracking, head checking, grease)
- Speed of test
- Name of the operator
- Ultrasonic flaw detector (type, serial No.)
- Probes used (type, serial No.)
- Couplant used
- Reference to test procedure
- Any variations from the requirements of the procedure
- Any test restrictions
- Rail temperature
- Any additional tests (reduced speeds, dye penetrant etc.) and results.

Note This can be on an individual form, however when the continuous ultrasonic testing is carried out it is more likely to be stored in a spreadsheet.

8 Site Marking

8.1 Rail Defects

Rail assessed as requiring remedial action or reassessment shall be painted yellow on the foot, web and side of head.

And where possible:

- The remove-by date, defect type and defect boundary could also be marked with white paint
- The priority of the defect can be marked with paint colours in addition to the yellow marking.

8.2 Weld Integrity

All new field welds when *ultrasonically tested* are to be sprayed with paint on both sides of the rail.

- Blue – if the weld is satisfactory
- As per 8.1 – if the weld is defective

8.3 Weld Geometry

All new field welds, when checked for *top surface straightness and alignment*, are to be sprayed with a paint dot on the web on both sides of the weld area approximately 100mm from the weld.

- Blue Dots – if the surface straightness is satisfactory
- Yellow Dots – if the surface straightness is not satisfactory.

The date of examination and identification code of the ultrasonic operator is also to be marked on the rail.