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Ultrasonic Testing By Continuous Rail Flaw Detection Vehicle

ETA-01-06

Applicability

ARTC Network Wide

SMS

Publication Requirement

Internal / External

Primary Source

2004 ARTC Ultrasonic Testing Agreement, ETE-01-02

Document Status

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1.0	30 May 24	Standards	Stakeholders	Manager Track & Civil Standards	Head of Engineering Standards 31/05/2024

Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	30 May 24		Document renumbered from ETE-01-02. Minor update to the wording on contractor defect reporting to improve clarity

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1 Introduction

1.1 Purpose

This specification establishes requirements to be met by the Ultrasonic Rail Flaw Detection *Contractor* on track owned or managed by Australian Rail Track Corporation (ARTC).

General requirements across the ARTC network are specified, together with specific variation of practices for testing in NSW, SA, Vic and WA.

1.2 Scope

This specification covers the minimum technical requirements that the Ultrasonic Rail Flaw Detection *Contractor* must comply with whilst testing rails on track owned or managed by ARTC.

1.3 Document Owner [Not applicable to Work Instructions]

The Head of Engineering Standards is the Document Owner. Queries should be directed to standards@artc.com.au in the first instance.

1.4 Reference Documents

The following standards are applicable to the contract:

- Australian Standard AS 2083
- ARTC Engineering Standards
- GPS Survey specification guidelines

1.5 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
A-scan	The A-scan presentation displays the amount of received ultrasonic energy as a function of time
B-scan	The B-scan presentations is a profile (cross-sectional) view of the test specimen

2 Technical Specification

2.1 Testing of rail for defects

The Contractor shall test the rail for new and existing rail defects. All defects shall be reported, sized and identified as new or existing. The *Project Manager* will advise the *Contractor* if testing of existing rail defects is not required.

Testing shall be carried out through level crossings, insulated joints and areas of the points and crossing that can be tested effectively.

2.2 Classification of rail defects

All rail discontinuities shall be classified by type and measured for precise size according to ARTC standards.

For a test car without the capability of automated classification and precise sizing of defects, identified defects shall be hand sized by a competent person.

2.3 Location of rail defects

Usually, the test car will deploy paint at the location of a rail defect.

If GPS locations of rail defects are not provided, the *Project Manager* is to direct the contractor on the appropriate marking and paint to be applied.

Where classification and precise sizing is done manually, the defective rail shall be marked for a length of 200mm, showing the location of the defect and its identification number as described in section 4.1.

2.4 Unsafe condition

The *Contractor* is to ensure any unsafe condition is reported. Some rail defects require immediate action upon detection and the *Contractor* shall notify the local maintenance representative if detected.

Remedial measures will be the responsibility of the local maintenance representative once advised by the *Contractor*. The *Project Manager* will provide the *Contractor* with details of corridor boundaries and local maintenance representatives.

A local maintenance representative may accompany the test car to expedite the response and remedial measures to any unsafe condition reported. The decision to have a local maintenance representative accompany the test car or not is the responsibility of the Area Manager.

2.5 Calibration

Equipment calibration shall meet or exceed the requirements specified in AS 2083.

The *Contractor* is to provide details of their current calibration procedures such as calibration intervals and comparison of test vehicles to ensure uniform results. The *Contractor* is also to provide details of current procedures where any maintenance activity affects the calibration of equipment.

Details of any periodic maintenance activity that does not comply with manufacturers recommendations for vehicles and equipment is to be submitted in conjunction with a risk analysis or a waiver from the manufacturer.

2.6 Testing schedule

The *Contractor* shall be responsible for planning and maintaining the testing cycle for the duration of the contract. Each cycle will be at least 1 month duration. This will require forward planning to ensure achievable inspection paths are organised. The *Project Manager* and other nominated representatives are to be provided with a program for each 1 month cycle at least 3 months prior to commencement. The *Project Manager* will advise the *Contractor* of any special testing requests.

The *Contractor* shall include contingency days in the program for “catch up testing”. Any section of track that could not tested during the run, must be completed at the end of the run or in accordance with the latitude described in ARTC Engineering Standards.

The *Project Manager* will provide the *Contractor* with track descriptions defining each run.

2.7 Specification for Contractor Supplied Ultrasonic Rail Flaw Detection Equipment

The *Contractor* shall provide a schedule of equipment to be used in the provision of services. The schedule should include:

- equipment proposed
- maximum speeds on & off track
- type of fuel & range
- water capacity & range
- the type of testing system
- Any limitations of the testing system i.e. any section of the rail that cannot be tested, track geometry conditions that will limit testing, climate limitations etc.

Equipment is to be maintained, calibrated and operated in accordance with agreed *Contractor* provided processes. The *contractor* will service, overhaul and replace obsolete equipment and carry out fault repairs to all equipment to provide the safety, reliability and measurement accuracy required by ARTC.

2.7.1 Detection Levels

At the start of each day, the equipment's operating detection levels shall be recorded. Any variations to these levels shall be subsequently logged.

The parameters to be recorded shall include:

- Pulse Count
- Sensitivity levels
- Calibration setting

2.7.2 Manual Equipment

A scan presentation shall be used (all alternative proposals to be supplied to ARTC for evaluation). The equipment shall be calibrated in accordance with AS 2083. Either analogue or digital equipment may be used.

Horizontal and vertical linearity shall be assessed for the test ranges used (with any distance amplitude correction switched off). Any deviation of horizontal linearity exceeding 2% over the full screen width or vertical linearity exceeding 2dB between 30% and 100% graticule height shall not be used.

2.7.3 Automated (vehicle) equipment

A-scan presentation shall be available for each flaw detector channel for calibration and routine checking. For the performance of test runs, the automated system may be used individually, or in combination with the following;

- Digitised data processing into numerical size and location displays
- Digital data processed into visual and/or audible displays
- B-scan

The only requirement is that the presentation shall be capable of indication reflectors within the resolution requirements specified in the clause on resolution below.

2.7.4 Overall gain system

The overall system gain shall be assessed in accordance with AS 2083 and shall not be less than 20dB.

2.7.5 Couplant

The *Contractor* is to supply details of average daily water consumption for testing. If other couplants are used, the *Contractor* shall supply a material safety data sheet with their tender.

2.8 Vehicle movement on or off tracks

The *Contractor's* road rail vehicles shall be capable of relocating on to or off tracks, without assistance from any other vehicles, in a period of five (5) minutes.

2.9 Quality Systems

The *Contractor* shall put in place and maintain quality systems and processes in accordance with the requirements of AS/NZ ISO 9000 series to ensure the integrity of the testing process and equipment used.

The *Contractor* is to submit a Quality Plan (complying with ISO 9000 series) for the work within four (4) weeks of the acceptance of the contract.

Within six (6) weeks of the end of each Testing Program, the *Contractor* shall provide one copy of all Quality Records to the satisfaction of the *Project Manager* suitably filed or bound.

ARTC reserves the right to audit the contractors technical and quality processes.

2.10 Assessment of Horizontal and Vertical Linearity

Horizontal and vertical linearity shall be assessed for the test ranges used (with any distance amplitude correction switched off). Any deviation of horizontal linearity exceeding 2% over the full screen width or vertical linearity exceeding ± two (2) dB between 30% and 100% graticule height shall be known and recorded. Suppression shall not be used.

3 Methods of Test

3.1 Automated Test Methods

3.1.1 Preparation for testing

The time base for each channel (probe) shall be calibrated or checked (if memory driven calibrations are used) using A-scan. This shall be performed on rail that is representative of that to be tested. Test ranges may be set for each probe using known artefacts e.g. foot of rail, bond holes, bolt holes, rail ends, etc. Test ranges shall be adequate to meet the scanning depths of this standard.

Gate positions shall be set or checked to ensure compliance with the scanning depth requirements of this specification. Prior to testing a brief run may be required to set interface gate widths accurately.

3.1.2 Probes

The rail shall be interrogated using a minimum of one 0° or 5° pitch / catch probe, one forward facing 70° probe, one rear facing 70° probe, one forward facing 35°-40° probe, one rear facing 35°-40° probe. Probe characteristics shall be known and recorded. Probe configurations shall be such that cross talk interference does not occur.

The *Contractor* shall submit details of any additional configurations that will be utilised.

3.1.3 Sensitivity

The specified areas of the rail shall be scanned using gain levels, that as a minimum, produce evidence of “grass” on the screen on all channels and a satisfactory back wall echo (50% - 80& graticule height) on the 0° channels. Threshold levels within defect gates shall be set just above “grass levels”. Gain should not be lowered where excessive interference occurs but rail surface, probe condition, etc, should be checked. If interference persists, threshold levels should be changed and gain maintained. Threshold levels may be set that utilise distance – amplitude corrections provided agreement has been reached and the *Project Manager* advised.

3.1.4 Pulse repetition rate

Pulses shall be generated for every 4mm of travel (maximum). Smaller increments shall be the subject of agreement between *Contractor* and *Project Manager*.

3.1.5 Pulse count

The selection of pulse count for eliminating non-significant non-destructive responses shall be the subject of agreement between the testing service and *Project Manager*.

3.1.6 Scanning requirements (test vehicle)

The 0° type probe shall be used to scan the central part of the rail head, the whole of the rail web and the central part of the rail foot perpendicular to the rail. The dead zone depth shall be known and recorded.

The 70° type probe shall be used to scan the rail head and part of the upper web.

The 38° type probe shall be used to scan the central part of the rail head, the whole of the web and the central part of the rail foot.

3.1.7 Evaluation

For any calibration (including PRR and pulse count) all signals above threshold shall be recorded. Individual signals or groups of signals interpreted as defects shall be evaluated by hand testing.

3.2 Manual Test Methods

3.2.1 Preparation for testing

Ensure that the rail surface conditions are such that:

- Uniform probe contact is maintained during the test.
- Surface roughness is not exceeded

It is preferred that the time base be calibrated in accordance with AS 2083. However, the use of a rail section and accurately known reflectors may be permitted by agreement between *Contractor*

and *Project Manager*. The test ranges selected for each probe shall be adequate to meet the scanning depth requirement of this standard. For the calibration of the time base, a V1 or V2 block must be used. Sensitivity setting may be performed using a rail sample.

Distance amplitude curves may be used in the assessment of discontinuities.

3.2.2 Probes

Similar probe angles to those used for automated testing shall be utilised. Probe characteristics shall be known and recorded.

3.2.3 Sizing

Defect sizing shall be performed using the 6dB drop method or the Last Significant Echo method. The *Contractor* shall advise ARTC which method shall be used. Suppression shall not be used.

4 Reports

4.1 Documentation by Contractor

The following requirement shall be established by the *Contractor*:

- Each defect is to be allocated an identification number.
- Additional to the size classification, the actual length of the flaw shall be indicated.
- The rail in which the flaw is located, shall be shown. The down rail is the left rail when facing in the direction of increasing kilometrage. The up rail is the rail opposite the down rail.
- The location of the defect with respect to the kilometrage posts to within ± 5 metres per 1,000m of the last km post encountered or GPS co-ordinates for each defect.
- Where two or more defects are found within one (1) metre of each other, the actual separating distance of the defects shall be indicated.

Additional requirements where a hand test is used to perform the defect measurement:

- The size, make and year of manufacture of rail..
- In the case of defective welds, the type of weld shall be indicated i.e. Thermit (T), Flash Butt (FB) or Wire Feed (WF)

4.2 Daily Ultrasonic Testing Report

All defects shall be classified as per the relevant standards. The *Contractor* shall also include the remedial action to be taken for defect removal relevant to the type of defect identified as per the standards.

A movement report describing all track tested, track programmed for test which could not be tested (i.e. missed track), start & finish times of the shift and any delays.

Where track conditions limit ultrasonic testing and sensitivity requirements cannot be met, then the location and length of the affected rail shall be recorded and reported to the *Project Manager* with a surface condition report. The *Contractor* shall provide a description of the testing problem e.g. grease, rust, gauge wear, rail surface damage, gauge corner damage, engine burns, rail surface delamination etc. It is important for the *Contractor* to provide locations where testing is becoming difficult so that rectification works can be programmed before Ultrasonic shielding

occurs. The *Contractor* is not required to identify locations where manganese components exist (in NSW) and testing could not be performed.

The *Contractor* must make every effort to test all rail within the section time available. The *Contractor* is to provide a documented process detailing recording speeds and any alternative couplants or additives to be used when loss of detection occurs at normal testing speed.

The *Contractor*'s reporting format shall be submitted for approval by ARTC prior to implementation. The *Project Manager* will advise the *Contractor* if extra data is required

4.3 Daily transmission of data

At the conclusion of each daily test, the *Contractor* shall produce an electronic daily report detailing:

- All defects found
- Movement report
- Surface condition report

The *Contractor* shall transmit the completed daily reports electronically by email to the ARTC *Project Manager* and nominated representatives at the completion of each daily test run. The *Project Manager* will advise the *Contractor* of ARTC's maintenance regions, nominated representatives and email address. This list will be regularly updated.

The daily reports are to be consolidated by the *Contractor* on a monthly basis and submitted to ARTC within 7 (seven) days. The delivery method is to be as approved by the *Project Manager*.

4.4 Monthly / Yearly Ultrasonic Testing Report

The *Contractor* will produce a regular Ultrasonic Rail flaw report and shall include the following details:

i. All daily test runs consolidated for the month,

ii. Exception Report - table indicating any missed track on the network and reasons for missing the track,

iii. comparisons with the overall number of defects detected for historical runs under previous contract in tabular, graphical format (ARTC to supply history),

iv. a breakdown of the whole ARTC network into type of defect (i.e. VSH, TD, NSD, etc) and priority faults (ie. Large, Medium and Small) (table and graphs),

v. break down of type of defect and priority faults (table and graphs),

vi. further breakdown of the results into maintenance corridors as specified by ARTC Project Manager into types of defects and priority (size) of defects (table and graphs),

vii. graphs showing the track time, etc (table and graphs),

viii. a description of the probes used, level of gains used and testing speed in comparison to previous runs and an indication that if anything has changed from previous runs what impact this will have on the level of defects found (i.e. so trending can still be done with the test results),

ix. trending of the NSD for the overall network by corridor (table and graphs),

x. average test speeds,

xi. trending of the number of Previous Defects found by corridor and state,

xii. details of all existing defects identified during the run.

For testing performed in NSW, the reports shall be produced monthly and should be completed and submitted to ARTC no more than one (1) month after completion of the run.

For testing in S.A., Vic & W.A. the reports shall be produced at the conclusion of the entire run and should be completed and submitted to ARTC no more than one (1) month after completion of the run.

4.5 Information to be supplied by ARTC

ARTC's *Project Manager* will supply to the *Contractor*, documentation to indicate the identity of the tracks being tested and recorded for subsequent use by the *Contractor* in defect identification and reporting e.g. Run Number, Basecode, Line, Road, Start & End km's, Maintenance Corridor.

4.6 Recording of Test Results

The *Contractor* shall keep records showing the following data for all test equipment used to detect rail flaws:

- All test readings sufficient for reviewing defects that may have been missed
- Location of test readings (to an accuracy of ±5 metres per 1000 metres from the last kilometrage or ½ kilometre post encountered). The test vehicles kilometre location is not to be reset at the ½ kilometre posts in SA or WA as these are not as accurate as the full kilometre posts.
- Location of readings from GPS co-ordinates (accuracy is described in ARTC's GPS Survey Specification Guidelines)
- Date of test readings

The *Contractor* shall maintain the records and make them available to the *Project Manager*, on request, for a period of eighty-four (84) months from the date of the test.

4.7 Broken rail reports

The *Contractor* will provide reports of defects or rail breaks found in the field no more than one month after being advised by ARTC of the defect. The *Project Manager* will advise the *Contractor* of the location to be investigated. The contractors report will include

- the location details
- date of failure and date of last test
- results of the investigation
- any improvements to prevent or reduce the likelihood of recurrence (by ARTC or the Contractor)
- any operator display download to verify the results of the investigation
- any additional comments.