



AUSTRALIAN RAIL TRACK CORPORATION LTD

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## Engineering Practices Manual Civil Engineering

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# Rail Repair using Wire Feed Welding

## RTS 3733

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### 1 Introduction

This standard establishes requirements for the repair of rail and crossings by qualified persons using approved wirefeed welding processes.

Wire feed welding is a semi-automatic welding process, using self-shielding flux – cored continuous wire. The process allows the operator to accurately place the weld deposit and to visually control the weld pool for maximum weld deposition and quality.

Wirefeed welding processes may be used to:

- build up fabricated and welded crossings manufactured from standard carbon and head hardened rail
- repair rail bound manganese and titan crossings
- repair wheel burns, Small EBTD, dipped aluminothermic and flash butt welds in standard carbon rail
- repair wheel burns, Small EBTD, dipped aluminothermic and flash butt welds in head hardened rail where axle loads DO NOT exceed 27 tonnes.

Wire feed welding processes are NOT approved for repairs of wheel burns in head hardened rail where axle loads exceed 27 tonnes. Repairs should be carried out using the approved aluminothermic processes.

### 2 Reason and Nature of Change

Reference to superseded standards TEP 15 and TEP 19 replaced with ETE-01-03.

### 3 Allowable Extent of Wear

The crossing should be welded when the wear is less than 5mm.

The effective repair limit for the building up of crossings is 10mm before starting. For crossing wear greater than this the chances of the repair falling increases substantially. Monitoring of the repaired crossing is to be increased in these circumstances.

### 4 Wires Approved for Welding

REPAIR TYPE	LINCORE 33	LINCORE M	Tri-s 19-9-6-0	TN3-0	B3-0	RESTRICTIONS
<b>Crossings</b>						
Standard rail	✓			✓		
Head hardened	✓			✓		
Vario	✓			✓		
RBM		✓	✓			Respiratory Protection Required No oxy/LPG gouging to be used
Titan					✓	
<b>Wheel burns</b>						
Standard rail	✓			✓		maximum depth 10 mm maximum length 200 mm
Head hardened	✓			✓		Up to 27 tonne axle load
<b>Rail ends</b>						
Standard rail	✓			✓		maximum depth 10 mm
Head hardened	✓			✓		Up to 27 tonne axle load

**Table 1: Wires Approved for Welding**

### 5 General Requirements

#### 5.1 Weld area

In order to ensure that an appropriate level of preheat is maintained throughout the welding process a restriction is placed on the length of wire feed welding that can be carried out to the head of the rail in one operation.

Wire feed welding **MUST NOT** be carried out over a length of rail greater than 200mm in any single operation.

This covers any form of wire feed repair due to wear or damage on plain rails such as continuous wheelslip or a series of individual wheelburns.

Any series of single repairs (each less than 200mm) must be separated by no less than 1 000 mm.

Additional repairs may be undertaken to extend a length already repaired only after the initial repair work has completely cooled (ie below 100 °C).

No restriction applies to the repair of crossing noses or wing rails except as detailed in Section for RBM Crossings.

## 5.2 Preheat

The area to be preheated is the weld area (maximum of 200 mm) plus a minimum 100 mm each side giving a total of 400 mm.

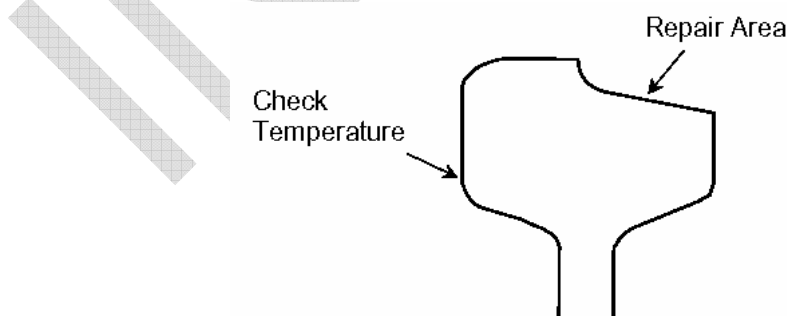
For the initial preheat the rail is to be preheated so that after the elapse of 2 minutes the required rail temperature is achieved. The required preheat rail temperatures are as shown in Table 2. The wait of 2 minutes is required to allow the preheat to soak into the rail.

Wire Type	Minimum preheat
LINCORE 33	350°C
TN3-0	350°C

**Table 2: Preheat Temperatures**

The preheat is to be tested before welding commences using a thermomelt crayon applied at the bottom of the rail head (see Figure 1).

The preheat must be not fall below this temperature until welding is completed. If welding is stopped for more than 3 minutes then an additional preheat and wait of 2 minutes is required and the temperature rechecked before welding is to recommence.

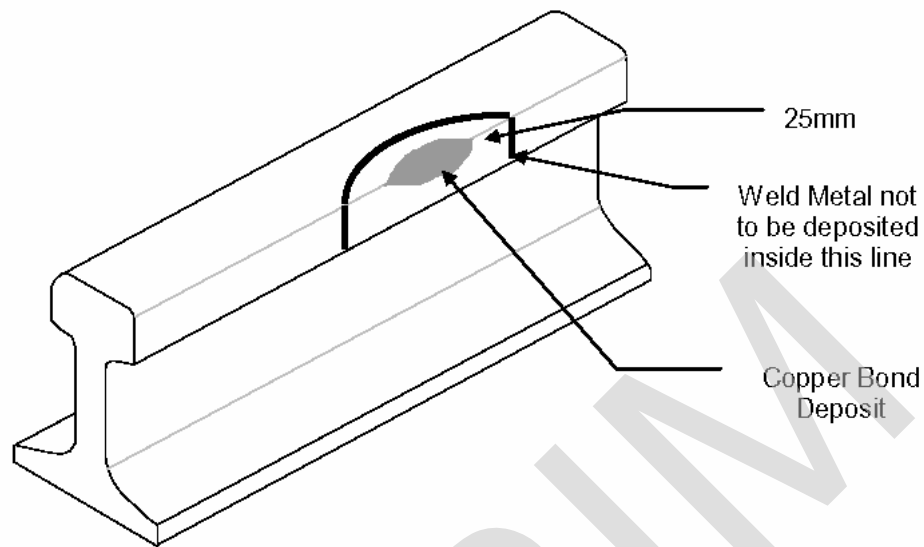


**Figure 1 - Location of preheat temperature check**

## 5.3 Copper bonds

On rails to which copper bonds are, or formerly were attached, weld metal must not be deposited within 25mm of copper bond position (see Figure 2). If this cannot be avoided the copper deposit is to be ground out. The purpose of the restriction on

the proximity of the welding to the copper deposit is to eliminate the possibility of copper penetration into the rail during the heating of the rail, whilst welding is in progress.



**Figure 2 - Welding near Bonds**

## 6 Work Requirements

### 6.1 Crossings

#### 6.1.1 Preparation

An ultrasonic test is to be undertaken within 1 week of proposed work.

If bolt hole defects are found, or defects are found that are not in the repair area, the crossing should not be welded as thermal stress induced during welding may lead to rapid crack propagation.

If defects below reporting size (see ARTC standard TES 02) are found they are to be recorded

If the cracking is in the area to be removed prior to welding its location should be noted to assist the welder determine the metal that should be removed.

Prior to welding:-

- tighten all crossing bolts
- pack all timbers, especially, the three under the nose
- check and tighten check rail bolts
- check checkrail effectiveness in steering wheels away from crossing nose and fix if necessary
- The rail or crossing must be properly aligned and leveled

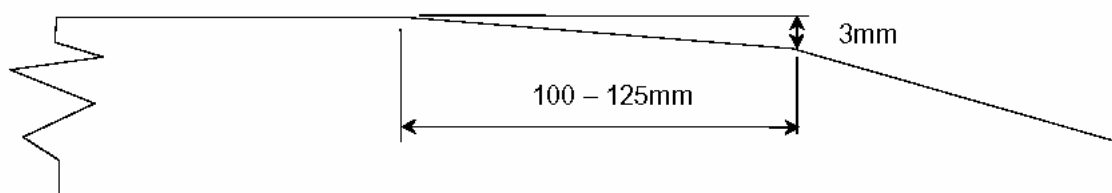
- Sleepers/timbers must be properly packed and in good condition
- All track fastenings must be correctly fitted
- All crossing bolts must be straight, in sound condition, of correct length with nuts fully threaded and properly tightened. Only one spring washer is to be used on each bolt.
- If Huck bolting is to be carried out this is to be completed before welding commences
- Clean the surface of the rail. If the crossing has previously been built up using oxy acetylene, then all the old oxy acetylene build up must be removed.
- Check the rail for old lamination welds and cracks which will become noticeable when heat is applied
- The damaged area plus 25mm each side is to be removed by either oxy propane gouging or grinding
- Remove sharp corners and ridges in the metal. All scale and slag (oxides steel) must be removed
- If oxy gouging is used then a minimum of 3mm below the level of the gouging must be removed by grinding before welding is commenced to remove any heat affected zone.
- Wheel burns must have 3mm removed below last crack found to ensure that all cracks have been removed

The following preliminary work must be completed prior to the proposed repairs:-

- Check flangeways
- Ultrasonically test crossing with particular attention to bolt holes. If there is any elongation or cracks around the bolt holes the crossing is not to be welded

### 6.1.2 Welding

The section of the crossing to be welded at the nose requires special attention. The nose is to be tapered to 3mm below the normal surface over a distance of between 100 – 125mm and the sides sloped to suite the existing rails.



**Figure 3 - Dimensions of Crossing nose**

Allow the weld to cool naturally.

**DO NOT QUENCH OR FORCE COOL THE WELD**

After the welding is complete the repaired area is to be ground to the correct alignment, cross-levels and longitudinal levels with particular attention to the crossing nose (see Figure 3). The wing rail can be ground using a profile grinder and the nose ground with the disk grinder. The points and crossing grinder can also be used.

### 6.1.3 Follow up Work

The following work is to be completed within 2 weeks after the repair:-

- grind off any flow which has occurred through work hardening
- recheck tightness of bolts
- check finished surface of repair and build up further if necessary
- ultrasonically test crossing in accordance with ARTC Standard ETE-01-03

## 6.2 Wheel Burns

### 6.2.1 Preparation

An ultrasonic test is to be undertaken within 1 week of proposed work paying particular attention to near surface cracks.

Before welding:-

- The rail must be properly aligned and levelled
- Sleepers/timbers properly packed and in good condition.
- Loosen rail fastenings and lift rail with wedges 15mm.
- If repair is at a joint ensure clear (min 5mm) separation exists between rail ends.
- Clean the surface of the rail. If the repair area has previously been built up using oxy acetylene, then all the old oxy acetylene build up must be removed.
- Check the rail for old lamination welds and cracks which will become noticeable when heat is applied.
- The damaged area plus 25 mm each side is to be removed by either oxy propane gouging or grinding.
- Remove sharp corners and ridges in the metal. All scale and slag

(oxides steel) must be removed.

- If oxy gouging is used then a minimum of 3 mm below the level of the gouging must be removed by grinding before welding is commenced to remove any heat effected zone.

### 6.2.2 Welding

Allow the weld to cool naturally.

**DO NOT QUENCH OR FORCE COOL THE WELD**

After the welding is complete and the repaired area is to be ground to the correct levels using a profile grinder.

Ultrasonic testing of the repair area plus 100 mm each side, paying particular attention to weld depth area (i.e. weld/rail interface), is to be completed within the timeframe specified in ARTC Standard ETE-01-03.

### 6.3 Welding Technique

The welding is to be carried out using **stringer beads** in a **pad configuration**

A Stringer bead is a **single** bead of weld (maximum 200 mm) with **NO** weaving.

Pad welding is the laying of a number of stringer beads where the next run overlaps the previous weld bead by half.

Where possible starts and finishes should not be in a single line.

Where multiple layers are necessary then the layers should not start and finish in the same line.

## 7 Speed of traffic over worksite

The maximum speed of traffic passing over crossing in the process of being repaired is 10 km/h. Normal speed may be allowed when welding is complete and crossing has been ground to profile.

## 8 Welder Identification

On completion of the repairs the welder must place welding identification stickers and paint his/her Licence number, location (km), and date of the repair on the foot of the rail within 600 mm of the repair. For wheel burn repairs the start and finish of the repair is to be marked on the head and web of the rail.

All wire feed welds are to be painted upon completion of the weld after grinding. A fluorescent pink line marking paint is to be used. The paint is to be applied from the top surface of the foot to the rail head excluding the running surface and cover at least 150mm either side of the weld and both sides of the rail.

## 9 Welding return

A Wirefeed Welding return (see Appendix 1) must be completed for each repair task at the end of each shift and given to the welder's supervisor.

The Delivery Manager or nominated representative shall keep a register of the location of all welds performed, the person who performed them and the reasons they were performed. The results of ultrasonic tests shall also be included in this register.

## 10 Repair of Rail Bound Manganese Crossings

This section sets out the safety requirements and procedures to be used for the repair of Rail Bound Manganese crossings.

**NOTE:**

Manganese crossings must be removed from the track before repairs can be carried out

### 10.1 General Safety Requirements

**IMPORTANT SAFETY NOTICE**

The fumes from the normal use of Lincore M contain significant quantities of manganese compounds. The manganese content in the fumes from Lincore M may affect the central nervous system, resulting in poor coordination, difficulty in speaking and tremor of arms and legs.

The area in which the welding is to be carried out should be isolated as far as possible from all staff not involved. Welders are required to use forced airflow welding helmets when grinding and welding. Welders Assistant/s in the immediate area to use disposable respirators.

A Fume Extraction unit and gun must be used at all times when welding.

Multiple sets of work clothes to be supplied to welders and welder's assistants who are required to weld manganese crossings. Clothes become contaminated and therefore, cannot be used for more than 2 days before washing. Work clothes are not to be taken home before washing.

Blood and urine tests are to be carried out and evaluated every 6 months.

The supervisor must keep a Register of employees involved in manganese welding including the date of welding and medical examination.

### 10.2 Preparation

The **MAXIMUM** temperature of the crossing must not exceed 150°C at any stage.



Preheat the area to be repaired + 200mm each side to 100°C. Check temperature using a digital thermometer.

Carbon arc gouge the areas to be welded.

Grind the areas to remove any gouge marks plus an additional 3mm of metal. The final grinding should be across the rail not along the rail as defects can be missed.

Carry out Dye Penetrant Testing as shown below. If cracks are found repeat the gouging/grinding process.

### 10.3 Dye penetrant test

- Surface is to be free from dirt, grinding sparks and grease
- Surface should be at ambient temperature (5°C to 35°C)
- Spray surface with cleaner and wipe off with clean, dry rag
- Spray surface with dye and leave for 10 minutes
- Wipe off with clean, damp rag when surface is dry
- Spray surface with developer and leave for 10 minutes
- Cracks will appear as red lines in the white developer

### 10.4 Welding

Sequence welding technique is to be used with a Maximum weld length of 100 mm and a maximum width of 20mm

Divide the areas to be welded into sections 100mm long and commence welding where the most build up is required.

Check temperature between each welding run

Grind edges between runs if required

When welding has been completed, remove all slag and scale which is still attached to the rail.

Grinding is to be carried out using disc grinder on the nose and the wing rails to achieve correct levels as shown in section 6.1.2.

Dye penetrant testing is conducted in accordance with section 10.3 and repairs conducted if required.

#### 10.4.1 Completed Levels

Cross levels are taken with 1m straight edge across the rails.

NOTE: All bolts are numbered from the front of the crossing.

- Casting wings are tapered 0 – 1mm towards the centre throughout the

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casting

- At the 2<sup>nd</sup> bolt hole casting wings and standard wing rails are level
- At the 3<sup>rd</sup> bolt hold casting wings are 3mm above standard wing rails
- At the 6<sup>th</sup> bolt hole casting wings are 3mm above standard wing rails
- At the 7<sup>th</sup> bolt hold casting wings, nose and standard wing rails are level

Longitudinal levels are taken with 1m straight edge along the top of the rail.

- Between the 2<sup>nd</sup> to 3<sup>rd</sup> bolt holes casting wings taper 3mm to 0mm.
- Between the 3<sup>rd</sup> to 6<sup>th</sup> bolt holes casting wings are level (3mm above standard wing rails)
- Between the 6<sup>th</sup> and 7<sup>th</sup> bolt holes casting wings taper 0mm to 3mm.

### Appendix 1: Wire Feed Welding Return

WELDERS NAME: .....

WEEK ENDING: .....

LICENCE No: .....

LICENCE No: .....			RAIL		WHEELBURN		CROSSING								ULTRASONIC RAIL FLAW DETECTION								
DATE	KM	ROAD	DN	UP	DEPTH	LENGTH	TYPE	NOSE		M.WING		T.WING		WIRE TYPE	COMMENTS	TEST DATE	DEFECT		SIZE	LOCATION			
								DEPTH	LENGTH	DEPTH	LENGTH	DEPTH	LENGTH				YES	NO					
Welder Signature .....																Name .....		Date .....		Comments .....		.....	
Date .....																Name .....		Date .....		Comments .....		.....	