Engineering Practices Manual

Civil Engineering

Wire Feed Welding Manual

RTS 3734

Issue A, Revision 0

March 2006

Scope

This document details the recommended procedure for Wire Feed Welding for rail and crossing repair in ARTC's tracks. The procedure meets the requirements of ARTC Engineering Practice RTS.3733 and should be read in conjunction with that document.

Reason and nature of change

Document reissued as ARTC Engineering Practice Manual.

General Information

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.

Contents

1 Safety information

1.1 Personal Safety Equipment

The following safety equipment must be used:

- Flip type welding goggles shade 5
- Long gloves
- Long pants and shirts
- spats
- safety shoes
- flint gun
- Welding helmet shade 11 or 12 lens
- special requirements for manganese welding

Never use faulty equipment.

Always wear safety glasses when chipping slag from weld

1.2 Protection of others

Place welding screens around welding area. Always inform the people standing near you, that you are about to commence welding. Inform them not to look at the arc. Welder's assistants must wear anti flash glasses.

2 Repairs in standard carbon and head hardened rail

2.1 General

The following method is approved for repair fabricated and welded crossings manufactured from standard carbon and head hardened rail, wheel burns, Small EBTD, dipped aluminothermic and flash butt welds in standard carbon rail, and in head hardened rail where axle loads DO NOT exceed 27 tonnes

2.2 Wires Approved for Welding

As detailed in RTS 3733

2.3 Approved Repairs

As detailed in RTS 3733

2.4 Work Procedure

2.4.1 Preliminary Inspection

A field inspection should occur as part of the planning process prior to welding to determine what work is required prior to welding or if welding will be viable.

2.4.2 Extent of wear

The extent of wear is to be measured by placing a 1000 mm straight edge across the worn area and measuring from the under side of the straight edge. Limits, detailed in RTS.3733, apply to the maximum depth of wear that can be repaired.

2.4.3 Preparation of Welding Surface

Cleaning

Clean the surface of the rail by heating the area with an oxy propane torch and brushing the area thoroughly with a wire brush.

Removal of previous build up

If a crossing or rail end has been built up using oxy acetylene, then all old weld must be removed by either grinding or oxy propane gouging then grinding.

Oxy / LPG gouging

Use Oxygen/LPG gouging tip 48GB

1. preheat rail
2. use low angle start gouging
3. increase angle until the desired depth is obtained
4. As the nozzle is moved forward the angle is reduced and increased as required to maintain the depth.

5. This is repeated until required length of the gouge is made

Checking for cracks, laminations or old welds

Check the rail for old lamination welds and cracks which will become noticeable when heat is applied.

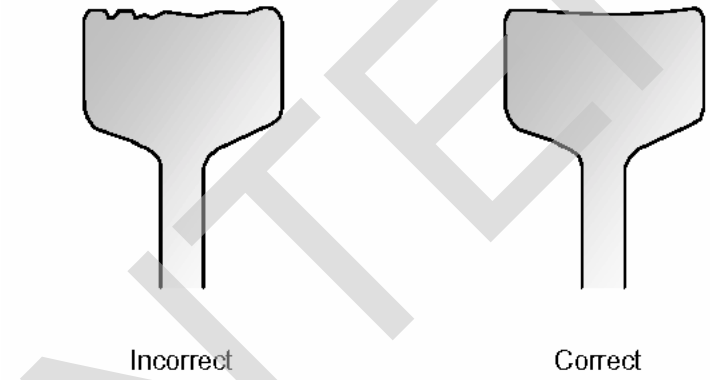
Note: Laminations and cracks will heat up and change to a bright orange very quickly while the sole metal will stay dark in colour. The laminations or cracks must be completely removed before welding is commenced. This is carried out using the oxy propane gouging torch. The surface should be reduced uniformly.

Grinding

The surfaces should be reduced uniformly so there are no deep craters.

Use an angle grinder to remove sharp corners and ridges in the metal. All scale and slag (oxides of steel) must be removed. If oxy propane gouging has been used a minimum of 3mm must be ground away to remove any heat effected zone.

The final grinding should be across the rail not along the rail as defects can be missed when magnetic particle testing.



Magnetic Particle Inspection

Note: This inspection must be carried out after oxy propane gouging and grinding of the repair area and before build-up is commenced. If any cracks are present at the surface of the rail they will be shown up by this test and should be removed.

- Remove any loose dirt or scale from the area to be tested
- Spray the area with a thin even coat of white background lacquer.
- Place the magnet particle test unit across the rail head over the area to be welded.
- With the magnetic test unit in position turn on then spray the black magnetic link on the area.
- If rapid bubbling of the ink or rapid evaporation occurs the area of the rail

being tested is too hot and must be allowed to cool before a retest is conducted.

- Check the results. A defect will show as a black line if a crack is found.
- Place magnetic particle unit along the rail and check again for defects.

Preheat

The repair must be preheated to the correct temperature for the wire in use (see RTS 3733 for details).

Preheat area

As per RTS 3733

Preheat check

As per RTS 3733

2.4.4 Welding

Welder Settings

Set the **Wirefeed Speed, Current** (amperage) control, **Voltage** and **Visible Stick Out** on the welder as indicated in Appendix 1 and Appendix 3 for the wire being used.

Electrical connections

Connect the wirefeed unit to the generator with electrode positive (DC reverse polarity). The wirefeed unit must be connected to the positive terminal of the welding machine.

Connect the earth (negative) wire from the machine and place it on the foot of the same rail that is to be welded, as close as possible to the weld area. The rail where the earth clamp is attached must be cleaned thoroughly with a grinder to ensure a complete metal to metal contact. Care must be taken not to damage the foot of the rail.

Protect power cables from falling objects, hot metal or slag.

Always feed cables under the track.

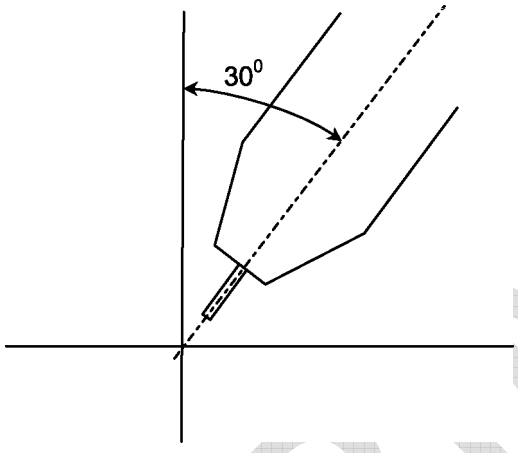
2.4.5 Weld Area

As per RTS 3733

2.4.6 Welding Technique

Draw Angle

The welding gun should be held with the drag angle of 30° from the vertical in the direction of travel.



When welding is stopped, remove all slag from welds before welding recommences.

When welding has been completed, remove all slag and scale which is still attached to the rail. Allow the weld to cool naturally. A slow cool contributes to reducing stresses.

The welding is to be carried out using stringer beads in a pad configuration as per RTS 3733.

2.4.7 Completion of weld

As per RTS 3733.

2.4.8 Grinding of weld

As per RTS 3733.

2.4.9 Quality Check

Carry out a quality check of the work.

Levels and alignment are checked using a 1 metre straight edge.

(a) **Wing Rails**: Place straight edge along the wing rail 15mm from gauge face. Repeat for each wing rail. Surface should be within 0.5mm of the straight edge.

(b) **Nose**: Place straight edge along the nose 15mm from the gauge face. Repeat for both running faces

(c) **Nose to Wing rail**: Place straight edge as in (b) above then move the nose end of straight edge to wing rail. Wing rail should be 2mm higher.

(d) For **rail not in crossings** (eg repair of wheel burns): Run a straight edge

from the gauge face to the field face of the rail. The rail should meet the following tolerances:

- Less then 0.5mm under the centre of the straight edge
- Less than 1mm under either end of the straight edge
- Running face and field face to have the above tolerances on straights
- On curves the distance from the running face to the straight edge is to be the same as on the rail either side of the repair.

Retest using the magnetic particle test. If defects are found carry out repairs as necessary.

2.5 Record of work

As per RTS 3733.

2.6 Welder Identification

As per RTS 3733.

2.7 Speed over Incomplete Repair

As per RTS 3733.

3 Repairs in rail bound manganese crossings

3.1 Special Safety Requirements

The RACAL airstream welding helmet with P2 filter part No 060-23-04 P MUST be used when grinding and welding.

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

The welders assistant/s in the immediate area must be issued with, and use, a disposable respirator (P2 Type)

Three (3) sets of work clothes are to be supplied to welders and welder's assistants who are required to weld manganese crossings.

A set of clothes may only be used for 2 days of welding before being washed. The washing of these clothes is to be arranged by the employees' supervisor.

The 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 Delivery Manager or nominated representative must keep a Register of employees involved in manganese welding including dates of welding and regular medical screening.

3.2 Wires Approved for Welding

As detailed in RTS 3733.

3.3 Approved Repairs

As detailed in RTS 3733.

3.4 Work Procedure

3.4.1 Preliminary Inspection

A field inspection should occur as part of the planning process prior to welding to determine what work is required or if welding will be viable.

3.4.2 Extend of wear

The extent of wear is to be measured by placing a 1000 mm straight edge across the worn area and measuring from the under side of the straight edge. Limits, detailed in RTS.3733, apply to the maximum depth of wear that can be repaired.

3.4.3 Preparation of Welding Surface

NOTE: The MAXIMUM temperature of the crossing must not exceed 150^0C at any stage during the preparation or welding process.

Preheat the area to be repaired + 200 mm each side to 100^0C.

Check temperature using a digital thermometer.

Carbon arc gouging

Carbon Arc gouge the areas to be welded.

Carbon Arc Settings.

- Amps(current) 200
- Job selector Mid Normal Range

Grinding

Grind the areas to remove any gouge marks. The surfaces should be reduced uniformly so there are no deep craters.

Cracks, laminations and old welds must be completely removed before welding commences.

Check Temperature

The final grinding should be across the rail not along the rail

Dye Penetrant Testing

NOTE: This inspection must be carried out after Carbon Arc gouging and grinding of the repair area and before build-up is commenced. If any cracks are present at the surface of the rail they will be shown up by this test and should be removed.

Carry out Dye Penetrant Testing as shown below.

- Spray area to be tested with No 3 Cleaner and wipe with rag.
- Spray area with No 1 red Dye and leave for 10-15 minutes.
- Spray area with No 2 Developer and leave till the area turns white.
- Cracks will appear as red lines.
- Clean off spray with No.3 and wipe with rag.

Preheat

The repair must be preheated to the correct temperature for the wire in use. (See RTS.3733 for details)

Preheat area

As per RTS.3733.

Preheat check

As per RTS.3733.

3.4.4 Welding

Fume Extraction Unit

The fume extraction gun is to be connected to the LN 22 and the extraction unit.

The power lead is to be connected to the 240 volt power point on the welding unit.

NOTE: No other 240v power units are to be used while the fume extractor is working and welding is being carried out.

Welder

Welder Settings

Set the **Wirefeed Speed, Current** (amperage) control, **Voltage** and **Visible Stick Out** on the welder as indicated in Appendix 1 and Appendix 3 for the wire being used.

Electrical connections

Connect the wirefeed unit to the generator with electrode positive (DC reverse polarity). The wirefeed unit must be connected to the positive terminal of the welding machine.

Connect the earth (negative) wire from the machine and place it on the foot of the same rail that is to be welded, as close as possible to the weld area. The rail where the earth clamp is attached must be cleaned thoroughly with a grinder to ensure a complete metal to metal contact. Care must be taken not to damage the foot of the rail.

Protect power cables from falling objects, hot metal or slag

Weld Area

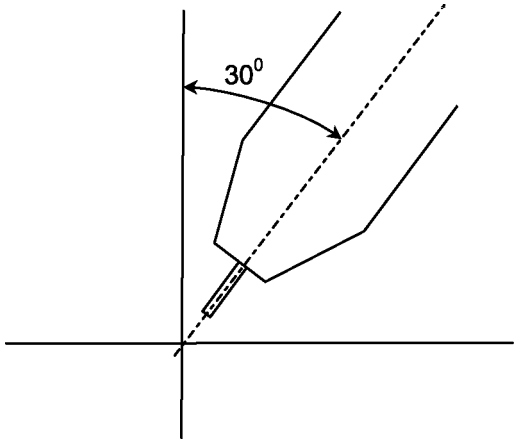
As per RTS.3733

Welding Technique.

A Sequence welding technique is to be used with a maximum weld length of 50 mm and a maximum width of 20 mm

A Drag angle of 30^0 off the vertical axis is to be maintained while welding

Divide the areas to be welded into sections 50 mm long and commence welding where the most build up is required.



Check the temperature between each welding run. Maximum Temperature must not exceed 150^0C

Grind edges between runs if required

When welding is stopped, remove all slag from welds before welding recommences.

3.4.5 Completion of the weld

As per RTS.3733.

When welding has been completed, remove all slag and scale which is still attached to the rail. Allow the weld to cool naturally. A slow cool contributes to reducing stresses

3.4.6 Grinding of weld

As per RTS 3733.

3.4.7 Quality Check

Carry out a quality check of the work.

Levels and alignment are checked using a 1 metre straight edge.

(a) **Nose:** Place straight edge along the nose 15 mm from the gauge face, repeat for both running faces.

(b) **Nose to Wing rail:** Place straight edge as in (b) above then move the nose end of straight edge to wing rail .Wing rail should be 2 mm higher.(see figure 4)

Retest using the Dye Penetrant test. If defects are found, carry out repairs as necessary.

3.5 Fume extraction unit cleaning and filter replacement

Warning. The dust and particulate matter collected by these filters can be dangerous to health. All workers cleaning and disposing of collected materials must follow manufacturers' documented instructions, and wear P2 respirators.

After consuming approximately 50 Kg of flux core wire, or when smoke removal is poor either clean or replace the filter in accordance with the procedure outlined in Appendix 5.

3.6 Record of work

As per RTS 3733.

3.7 Welder Identification

As per RTS 3733.

Appendix 1: Specifications

A-1-1 Lincore 33

Welding	
Pre Alignment (Wheel Burn Only)	15mm to 25mm between Rail and Sleeper Plate
Magnetic Particle test	test before preheating
Preheat	350°C
Wait before Welding	2 minutes
Stick Out	15-25
Machine settings	
Volts	25
Amps	260-270
Wire Speed	4.25 / 160
OCV	Normal

A-1-2 TN3-0

Welding	
Magnetic Particle test	test before preheating
Technique	Stringer Beads Pad Welding
Preheat	350°C
Wait before Welding	2 minutes
Stick Out	40mm
Machine settings	
Volts	27
Amps	260-270
Wire Speed	4.25 / 160
OCV	Normal

A-1-3 Tri-s 19-9-6-0

Welding	
Dye penetrant test	test before welding
Welding Technique	Stringer Beads
Preheat	50°C
Wait before Welding	2 minutes
Stick Out	15-25
Maximum Temperature	150°C
Machine settings	
Volts	25
Amps	260-270
Wire Speed	4.25 / 160
OCV	Normal

Air Arc Gouge	
Air Pressure	100psi
Rod Size	6mm
Amps	225
OCV	Normal

A-1-4 B3-0

Welding	
Magnetic Particle test	test before preheating
Technique	Stringer Beads Pad Welding
Preheat	350°C
Wait before Welding	2 minutes
Stick Out	40mm
Machine settings	
Volts	27
Amps	260-270
Wire Speed	4.25 / 160
OCV	Normal

A-1-5 Lincore M

Welding	
Dye penetrant test	test before preheating
Welding Technique	Stringer Beads
Preheat	50°C
Wait before Welding	2 minutes
Stick Out	15-25
Maximum Temperature	150°C
Machine settings	
Volts	25
Amps	220
Wire Speed	3 / 90
OCV	Special
Air Arc Gouge	
Air Pressure	90-120 psi / 25 cfm
Rod Size	6mm
Amps	220
OCV	High

A-1-5 Lincore M

Tip Size	Oxygen (KPA)	LPG (KPA)
48gb	600	150

Appendix 2: Welding machine

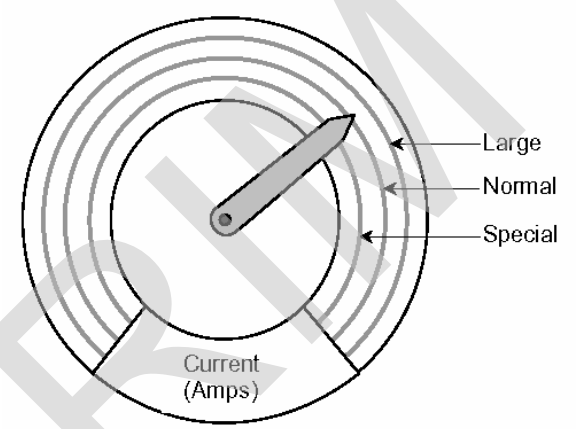
A-2-1 Lincoln 400 AS

A-2-1.1 Current (AMPS)

Set the current (amps) control to the required setting for the type of wire being used (see section 9).

Note it is essential to keep the machine on the correct setting because variations of this control have the following major effects:

- Change the melt off and deposition rates, which can cause lack of fusion.
- Excessive current produces convex beads and under cut on edges of beads.
- Too low a current will give large droplet transfer and stubbing.



A-2-1.2 Voltage

Set the Job Selector (OCV) control to the normal welding position and adjust the control until the volt meter on the wire feed unit is showing the volts for the wire being used.

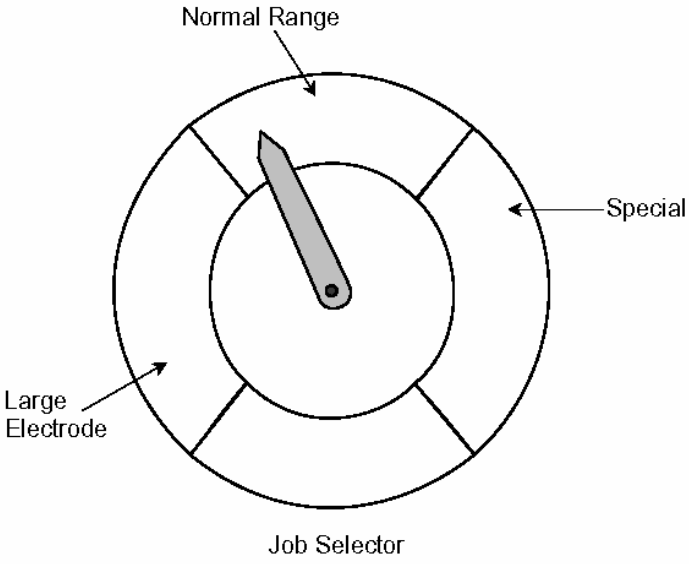
Variations of voltage has the following effects:

Higher voltage results

- in a wider flatter bead.
- large amounts of splatter.
- porosity

Low voltage results

- in a convex (ropy) bead
- stubbing



A-2-1.3 Wire speed

Set the wire speed metre (on the speed control dial on the end of the wire fee unit) to the value required for the wire being used.

If the current, voltage and the stickout are held constant, wire speed variations have the following effects:

- An increase in wire speed results in stubbing
- An increase in wire speed results in convex beads
- A decrease in wire speed results in wire burn back to tip.

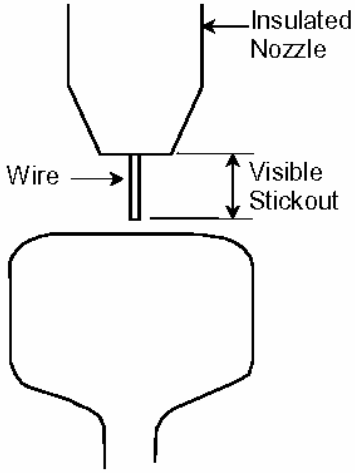
A-2-1.4 Visible Stickout

The visible stickout is measured from the bottom of the insulated nozzle to the end of the wire.

This is set to the stickout for the type of wire in use.

Variation of the visible stickout has the following effects:

- Increased stickout DECREASES the welding current
- Decreased stickout INCREASES the welding current



Appendix 3: Trouble shooting

A-3-1 To eliminate Porosity

(in order of importance)

- Decrease voltage.
- Increase stickout.
- Increase drag angle
- Decrease speed
- Increase currant

A-3-2 To eliminate Ropy convex bead

- Increase voltage
- Decrease stickout
- Increase drag angle
- Decrease current
- Decrease speed

A-3-3 To eliminate splatter

- Increase voltage
- Decrease stickout
- Increase drag angle
- increase current
- Decrease speed

A-3-4 To eliminate stubbing

- Decrease wire speed
- Increase voltage
- Decrease drag angle
- Decrease stickout
- Decrease current

A-3-5 To eliminate poor penetration

- Decrease stickout
- Increase current
- Decrease voltage
- Increase speed
- Increase drag angle

A-3-6 To eliminate Arc Blow

- Increase drag angle
- Increase stickout
- Decrease voltage
- Decrease current
- Decrease speed.

Appendix 4: Approved Hardware and Consumables

A-4-1 Repairs in standard carbon and head hardened

Hardware

ITEM	SUPPLIER	PART No
Welding Machine	Lincoln	400as
Wire feed unit	Lincoln	LN 22
Magnetic Particle test unit	Chemi-Clean Pty Ltd	Lectromax 2000

Consumables

ITEM	SUPPLIER	PART No
Welding Wire	See RTS 3733	

A-4-2 Repair of RBM crossings

Hardware

ITEM	SUPPLIER	PART No
Welding Machine	Lincoln	400as
Wire feed unit	Lincoln	LN 22
Airstream Helmet	Protector	Racal AH 1
Fume extraction unit	Lincoln	Linconditioner
Fume extraction Gun	Lincoln	K 206

Consumables

ITEM	SUPPLIER	PART No
Welding Wire	See RTS 3733	
Pre Filter	Protector	0602200P
Main Filter	Protector	060-23-04P

Appendix 5: Fume extraction unit cleaning and filter replacement

WARNING

The dust and particulate matter collected by these filters can be dangerous to health. All employees cleaning and disposing of collected materials must wear P2 respirators.

A-5-1 Filter Cartridge Replacement

Disconnect power from 240v outlet.

Remove clamping ring from top of filter canister.

Remove top of filter canister and remove wing nut from bottom of filter

Remove filter and immediately place in a large clear plastic bag

Place any collected material from bottom of filter canister into plastic bag.

Note: Care must be taken not to dislodge collected material from filter into the atmosphere.

A-5-2 Filter Cartridge Cleaning.

Disconnect power from 240v outlet.

Remove clamping ring from top of filter canister.

Remove top of filter canister and remove wing nut from bottom of filter

Remove filter and immediately place in a large clear plastic bag

Place any collected material from bottom of filter canister in to plastic bag.

Without removing filter from plastic bag gently brush the collected material off the outside of the filter.

Loosen dust by successively dropping the filter approximately 25 mm on to a hard surface while rotating 10 to 20 degrees after each drop. Do not drop filter on its corner.

Secure the bag around gasket end of the filter and blow compressed air through the filter.

Air supply must be 550-700 kPa (80 - 100 psi) and nozzle should be kept at least 25 mm away from the filter element.

Repeat dropping procedure

Before removing cleaned filter from plastic bag again gently brush any adhering dust from the outside of the filter.

A-5-3 Disposal of Particular Material.

Measure out one part of sodium sulphate (Na2SO4) for every three parts of fumes to be treated.

Add to plastic bag of fumes and shake to mix.

Seal bag.

A-5-4 Disposal of used filter cartridges

Weigh the element and the collected particulate material after it has been placed in plastic bag.

Subtract weight of new filter.

Measure out one part of sodium sulphate (Na2SO4) for every three parts of fumes to be treated.

Add to plastic bag containing the used filter and collected materials.

Seal bag.