1. OBJECTIVE

The objective of the guidance note is to identify the factors that must be considered and controlled to achieve satisfactory repair welds in crane rails. The ultimate objective is to make the Australian fabrication industry more competitive by reducing maintenance costs.

2. INTRODUCTION

Situations arise where crane rails need to be replaced or repaired due to localised wear, fatigue cracking or weld cracking.

This note identifies the factors that affect the performance of repair welds in crane rails and provides guidance to repair and maintenance personnel.

3. BACKGROUND

3.1 Crane Rail Chemistry

Crane rails are made from carbon manganese steels conforming to AS 1085.1 Railway track material – Part 1 Steel rails.

Carbon (C) up to 0.82 % maximum

Manganese (Mn) up to 1.25 % maximum

4. CRANE RAIL WELDABILITY

Carbon equivalent (CE) – Highest possible based on maximum allowable chemistry.

$$C.E._{(IIW)} = C + Mn/6$$
$$= 0.82 + 1.25/6$$
$$= 1.03$$

This $C.E._{(IIW)}$ is very high and therefore hydrogen control, preheat and interpass temperature control are very important.

If the chemistry of a particular rail is known the above formula can be used to calculate the $C.E._{(IIW)}$.

5. CRANE RAIL MAINTENANCE WELDING

5.1 Butt welds

Replacement of rail sections. Aluminothermic welding should be considered where butt welds are required

Preparation – Butt Welding

- Flame cut, gouge / machine / grind to form a square end on the rail.
- Dress all gouged and flame cut surfaces to remove slag and provide a smooth notch free surface.
- Rail ends are square butt welded by setting 16-19mm apart.
- Prepare a 4-6mm thick steel insert at the weld root the width of the gap and length equal to the rail foot width.
- Copper shims are stacked or a machined, solid block of copper with a recess at the weld zone are used to form an enclosure for the weld pool whilst allowing excess slag to run free

Temporary Backing

- Good surface profile underneath the weld root area will maximise fatigue resistance of the joint
- Initial support for depositing the root can utilise a copper backing plate or ceramic backing (wire-reinforced window glass has been used in rare cases)

Backing Insert

- Place a backing insert of carbon steel

5.2 Pad welds

Repair to local damage due to wheel burns, corrugations, batter of softer welds etc.

Preparation – Pad Repairs

- Grind off all flowed or mechanically damaged material to a suitable profile for weld build up.
- Check the surfaces to be welded for cracking using magnetic particle inspection (MPI) or dye penetrant inspection (DPI).

5.3 Crack repairs

Repairs of damage due to fatigue cracking in service.

Preparation – Crack Repairs

- Identify all crack locations – visual inspect and magnetic particle inspection (MPI) or dye penetrant inspection (DPI) or ultrasonic inspection (UT).
- Gouge or grind out crack
- Confirm crack removal – MPI or DPI
- Grind or burr to sufficient depth to remove all carbon contamination where gouging has been performed

6. PREHEAT REQUIREMENTS

The preheat necessary for welding these steels is a minimum of 300°C. The interpass temperature should be controlled within the range of 300°C minimum to 400°C maximum.

6.1 Preheat Method

Use multiple LPG heaters set up in a stand. Heating should continue to maintain a minimum preheat of 300°C during the entire welding operation. Verify preheat temperature with a contact thermometer, temperature indicating crayon or thermocouple. The width of the heated zone should be 150 mm minimum each side of the weld zone. Ensure a proper soak of temperature to ensure that the full section thickness is preheated to the correct temperature. The preheat temperature can be checked by removing the heat source for a minute or two and re checking the temperature. If the temperature has dropped more preheat needs to be applied.

It is sometimes difficult to maintain preheat and protect the welder from the flame, exhaust gases and radiant heat. Screens may be set up to protect the welder from hot gases and radiant heat from the heated rail. Flame heat from the opposite side of the rail to the welder

7. WELDING CONSUMABLES

7.1 MMAW

Metrode Railrod.

Electrode size 3.2 mm

An alternative is AS 1553.1 E4818 or E4816 electrodes. These electrodes have lower hardness and will have a lower wear life. If the weld is finished 4 to 5 mm below the top surface the remaining layer can be deposited utilising a hard facing consumable with similar hardness to the rail head.

7.2 FCAW

Flux-cored arc welding (FCAW) consumable conforming to AS 2203.1 – 1990 : ETD-GXp-W769A.K4 H5

Examples are: – CIGWELD TENS-COR 110 TXP, WIA FLUXOFIL M42 H5, SWP SPEEDARC X110T5-K4.

Electrode size 1.2 mm or 1.6 mm

8. GENERAL WORK INSTRUCTION

- Dress off any flowed metal from the sides and top surface by grinding.
- Confirm sound metal by magnetic particle testing.
- Ensure minimum preheat is established for a distance of 150 mm minimum away from the repair area in both directions, before commencing welding.
- This includes tack welding for backing bars and run-on and run-off tabs.
- If the cracks are still evident on the top surface, continue excavation checking with magnetic particle examination in incremental stages until all evidence of cracking is removed. Ensure the excavation forms a suitable groove for re-welding.

- If the crack continues into the web it may be advantages to cut the rail and do a butt weld or replace a section of rail.
- If a deep groove is made in the head, use backing bars and run-on and run off plates.
- Weld the groove in the head (if required) before building up.
- Weld three runs transverse at each end of the depression. See Figures 1 & 2.
- If stop/starts are required other than at transverse welds at either end, ensure that they are staggered.
- Place the second and subsequent longitudinal runs with the arc directed at the toe of the previous longitudinal weld run. See 6. Above.
- Grind all welds to match the rail profile

9. SUMMARY

Factors affecting the quality of weld repairs to rails have been identified.

The chemistry limits of rail material are given.

The carbon equivalent is calculated, based on maximum chemistry limits.

The need for hydrogen control, preheat and interpass temperature control are highlighted.

Guidance on preparation for butt welding, pad welding and crack repairs is given.

Preheating and interpass temperature requirements are given.

Guidance is provided on methods of preheating and measuring preheat and interpass temperatures.

Welding consumables for the MMAW and FCAW processes are given with examples of products available in Australia.

A general work instruction is given for welding on crane rail.

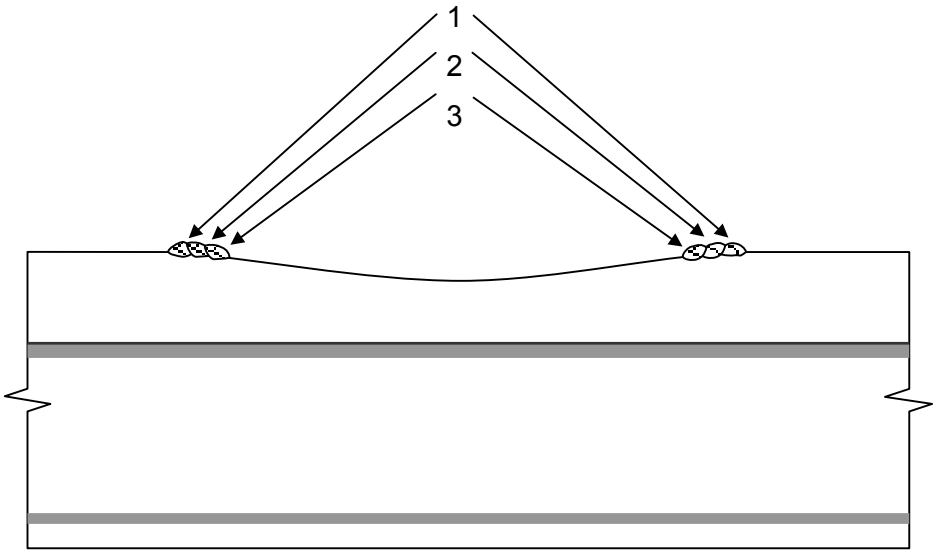

Figure 1. Side view of the rail showing three transverse runs at the run-out of the depression.

Figure 2. Top view of the rail head showing three transverse runs at the run-out of the depression.

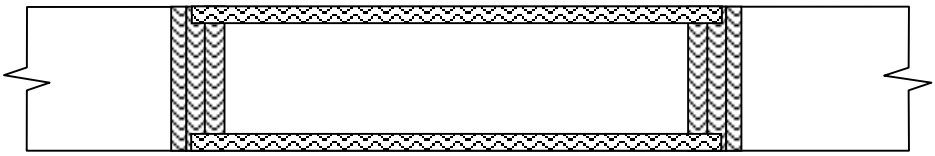

Figure 3. Top view of the rail head showing longitudinal runs starting and finishing on the transverse runs at the run-out of the depression.

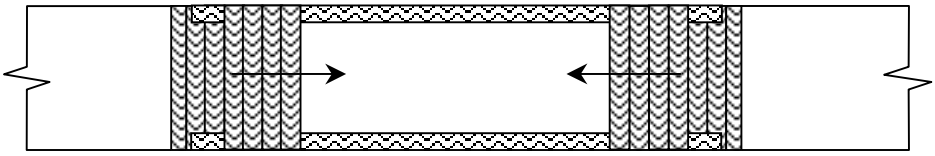

Figure 3. Top view of the rail head showing direction of progression of transverse runs starting and finishing on the longitudinal runs.

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NDNP TECHNOLOGY DIFFUSION ACTIVITY # 27	Welding Technology Institute of Australia ABN 69 003 696 526 **NATIONAL DIFFUSION NETWORKS PROJECT** **TECHNOLOGY QUESTIONNAIRE** **Building & Construction Industry Group** **"Repair welding of crane rails"**	**Document No:** 9.4.3QR-000X **Revision No:** Rev 0 **Page 1 of 2** **Date:** 30 May 2006

As part of the WTIA National Diffusion Networks Project the Building & Construction Industry Sector identified the need for guidance on the repair welding of crane rails. The WTIA has prepared a Technical Guidance Note "Repair welding of crane rails" to help understand the issues relating to maintenance welding on crane rails and offer solutions to improve the performance of repairs. As a valued technology expert in this area we would like you to be part of the Technology Expert Group to review this note. Please complete this questionnaire so that we can gauge the success of meeting this need.

Objective 1: Identify the factors that influence, and offer solutions to improve the quality of welding for crane rail repair

Situations arise where crane rails need to be replaced or repaired due to localised wear, fatigue cracking or weld cracking. This note identifies the factors that affect the performance of repair welds in crane rails and provides guidance to repair and maintenance personnel. How well does the document explain the issues relating to maintenance welding on crane rails and offer solutions to improve the performance of repairs?

poor ☐ average ☐ good ☐ very good ☐

Comments: _____

Objective 2: Identify appropriate technology receptors in the Building & Construction Industry

This document was written for Designers, Fabricators and Maintenance practitioners in the Building & Construction Industry. Are these people the appropriate individuals we should be targeting?

yes ☐ no ☐

What other types of companies and/or personnel do you suggest we target? _____

_____

Objective 3: Identify best practice

The document was written to reflect current best practice and latest technology for maintenance welding of crane rails. Do you envisage opportunities for the use of this technology in the industry?

yes ☐ no ☐

If yes, what and where, if no why not? _____

_____

Objective 4: Is the information provided clear, concise and accurate?

yes ☐ no ☐

If not, why? _____

Objective 5: Broad dissemination of technology to the Building & Construction Industry

Please indicate how best to disseminate this Technical Guidance Note to the appropriate Building & Construction Industry Recipients

Free Website Download ☐ Poster☐ Pocket Guide ☐ Pamphlet ☐

If poster, what size? A1 ☐ A2☐ A3 ☐ Laminated ☐ What selling price? $

If a pocket guide, what selling price? $

Other format? _____

Objective 6: Continuous Improvement

Please Identify areas where the document can be improved or return the document with your recommended additions/amendments. Alternatively, please use the area below to provide any additional comments.

*Respondents Name:*_____ *Company:* _____ *Phone:* _____

Fax: _____ *Email:* _____ *Date:* _____

Please Fax (02 9748 2858) or E-mail (b.gross@wtia.com.au) your response. Your prompt response is appreciated.

The WTIA has joined forces with industry and government to create a 3.5 million dollar Technology Support Centres Network. This network will assist industry to identify and exploit world's best technology and manufacturing methods to establish a vibrant Australian industry beyond 2006. Together we will be implementing a step by step process which will lead to ongoing viability and greater profitability for all concerned:

(1) Determine your technological and manufacturing needs;
(2) Identify world's best practice;
(3) Draw upon the network to implement world's best practice at your site