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NR/L2/TRK/0132 Issue 6

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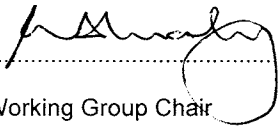
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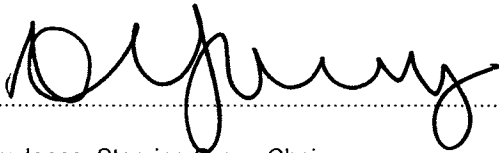
Maintenance Arc Welding of Rails, Switches and Crossings

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Issue record

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01	Jan 1997	New specification (incorporating content of InterCity Engineering Instruction IT/TI0101
02	Aug 2000	Revised to allow for the use of Railtrack-approved semi-automatic welding processes
03	Feb 2003	Addition of procedures for plain line rails and retitling
04	Feb 2007	Incorporation of TNC's; amendment to main body of text which includes: reference to track engineering forms (welder report and switch repair forms deleted); revision of welder training, competence and certification requirements; amendment to rail steel identification; amendment to preheating requirements; revision of NDT and weld inspection requirements; change to deposition techniques; amendment to initiation of and site checks to switch repairs; new sections covering the welding requirements and procedures for crossings and track-circuit deposition; document retitling
05	Aug 2008	Updated to reflect Phase 2A reorganisation
06	Dec 2010	General tidying up of document; updated to reflect Engineering reorganisation (Nov 2009); requirements for Competence and Training removed and referenced to new document; incorporation of NR/BS/LI/181 for weld repairs to tri-metal zones on AMS crossings, new section covering measurement and inspection equipment; addition of 350MHT into normal grade group rail for welding purposes; increase of weld run lengths when using cored wire processes; amendment to welding procedures to allow welding of squats above fishplate limits; repair to rail end batter no longer permitted in Category 3 track; restriction when welding in red zones to maximum line speed of 20mph; new section dealing with sidewear repair to switch blades with fully-automatic processes; new requirement for maximum wear before repair welding of crossings; amendment to running table alignment acceptance requirements in Table 1; reference and addition of new alloyed steel grades; change of requirements for welding into RCF; new Appendix C; change to references.

Compliance

This Network standard is mandatory and shall be complied with by Network Rail and its Contractors if applicable from 4 June 2011.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

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PART A: GENERAL REQUIREMENTS

A.1 PURPOSE

This specification defines the methods to be used when weld repairs to plain rail and switch and crossing components are carried out. It also specifies the permissible limits of defect and damage to be removed, including sidewear for specific rail steel types. Procedures for track-circuit deposits (zig-zag deposits) are also included.

A.2 RESPONSIBILITIES

Network Rail and/or Contractors' staff shall be responsible for ensuring that:

- All welding procedures are qualified in accordance with the requirements of section A.3.1
- All welders carrying out weld repairs are qualified in accordance with the requirements of section A.3.2
- A thorough inspection of the rails and/or switch & crossings is carried out to establish those repairs required
- All the necessary details are recorded on the relevant welders work return forms, TEF/3004 - plain line repairs, TEF/3008 - switch repairs, TEF/3009 - crossing repair/maintenance
- All loose debris and combustible materials are removed to provide a safe working environment
- The area of the plain rail to be repaired is thoroughly cleaned immediately prior to the commencement of welding using a suitable degreasing agent. It is essential that all grease and lubricants are removed to prevent fumes
- All weld repairs are inspected within the specified timescales. Exceptions to this time limit shall be permitted where access requires special arrangements. All necessary details are to be recorded on the relevant welders work return form
- The relevant welders work return form is retained for a period of 2 years for audit purposes.

At the initial site visit the rail shall be inspected for defects which would necessitate replacement of the rail (see NR/L2/TRK/001).

A.3 WELDING REQUIREMENTS

A.3.1 Welding procedure requirements

Welding procedures shall be qualified and approved in accordance with the requirements of BS EN ISO 15613 for all rail grades to be welded. All welding procedures and welding procedure specifications (WPS's) shall be approved by Network Rail prior to being used in Network Rail managed infrastructure.

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A.3.2 Welder Training, Competency and Certification

The requirements for welder training, continuing competency and certification, can be found in Network Rail Standard, NR/L2/CTM/222; Competence and Training in Track Welding, Weld Inspection and Ancillary Processes.

A.3.3 Welding plant and equipment

All plant and equipment shall be subject to maintenance in accordance with the manufacturers' recommended requirements and testing schedules shall comply with those requirements, the details of which shall be documented for audit purposes. The schedules shall include the correctness of amperage setting, engine speed, voltage output, voltage regulation, wire feed speeds and tachometer readings of associated grinder spindles as appropriate to the technique and process. Lists of welding plant and equipment required for plain rail and switch and crossing repairs are given in Appendices A, B and C.

When using the flux-cored arc welding (FCAW) process, the power source shall provide direct current (DC) or rectified alternating current (AC).

A.3.4 Measuring and inspection equipment

All measuring and inspection equipment used for the production and final inspection of arc weld repairs shall be maintained in accordance with the requirements of NR/L2/RMVP/0172 and NR/L3/RMVP/0201. Master equipment used for calibration and validation purposes shall be calibrated against relevant UKAS requirements and certificated accordingly.

A.3.5 Rail steel identification

The welder shall check and identify the grade of rail steel or crossing component to be welded. Where a rail steel or crossing component cannot be positively identified, the rail or crossing component in question shall not be welded.

Rails are usually identified by a combination of alpha-numeric brand markings on the rail web. The various identification of brand markings according to age of rails, grade, relevant standard and manufacturer, can be found in Table 1.

Crossings manufactured from cast austenitic-manganese steel (AMS) or Bainitic (also known as Titan) steel, have the type of material cast onto the side of the crossing in the form of raised lettering. Cast crossings can also be identified by the use of a magnet. AMS shows little or no attraction to a magnet.

A.3.6 Manual metal-arc (MMA) electrodes

All electrodes shall be kept in a dry and heated store in accordance with the manufacturers' recommendations.

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Only Network Rail approved electrodes of 2.5mm, 3.25mm and 4.0mm diameter shall be used for plain rail and switch and crossing weld repairs. Approved electrodes can be found in Table 2.

Electrodes shall be examined for contamination, moisture or damaged flux coatings. Electrodes found with any of these conditions shall not be used as this could result in porosity or cracking in the weld deposit.

Sufficient electrodes to complete the work shall be available at the site.

Vacuum packed electrodes shall be used in accordance with the manufacturers' recommendations.

Non-vacuum packed electrodes shall be dried in accordance with the manufacturers' recommendations, but if this cannot be achieved with the equipment available, in accordance with the instructions specified on the relevant WPS before being taken into use.

A.3.7 Self-shielding FCAW wires

All flux-cored wires shall be kept in a dry and heated store in accordance with the manufacturers' recommendations.

Only Network Rail approved flux-cored wires of 1.2mm and 1.6 mm diameter shall be used for plain rail and switch and crossing weld repairs. Approved flux-cored wires can be found in Table 2.

Flux-cored wires shall be examined for contamination with grease, oil, rust etc, moisture, kinks or a damaged outer sheath. Flux-cored wires found with any of these conditions shall not be used.

Sufficient flux-cored wire to complete the work shall be available at the site.

A.3.8 Welding cables

Welding cables shall conform fully to the requirements of relevant European/International Standards and be of a length and cross sectional area compatible with the welding power source and selected current. They shall not exceed 14m when using AC and 18.5m when using DC power supplies.

The welding cables shall not be used when tangled or coiled. The cable fitted with the electrode holder shall be permanently and clearly marked at the power source connection end. When using AC the welding and return cables shall be taped together throughout their length and shall not be used when separated.

Welding cables shall not run parallel to any rail for more than 10m to avoid inductive interference with track circuits.

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The foot of the rail to be welded shall be lightly ground, as close as possible, but no more than 2 metres from any point of welding, such that a good electrical contact will be made when the return current clamp is fitted.

The return current clamp shall be fitted tightly to the foot of the rail at the nearest ground position to the point of welding.

A.3.9 Preheating requirements

A.3.9.1 Normal grade group

The temperature of the rail over the area to be welded, including an additional 75mm at each end, shall be subjected to an initial preheat of 343°C minimum, maintained throughout welding.

Bainitic rail steels shall be preheated to a minimum temperature of 200°C with the maximum temperature not exceeding 350°C. Bainitic steel shall also be subject to a maximum interpass temperature of 300°C.

Care shall be taken when preheating not to subject the rail to excessive heat. Only one rail heater shall be used, at any one time, on any single rail or switch and crossing component.

All temperature checks shall be carried out by the use of a suitable temperature indicating crayon and shall be measured 75mm from each end of the excavated area and at the bottom of either side of the rail head.

A.3.9.2 AMS

Preheating is not required for AMS. However, to avoid embrittlement of the rail, the temperature during welding shall not exceed 204°C. The temperature of the rail shall be measured after each weld run, adjacent to the weld deposit, allowance being made for equalisation of heat following deposition.

A.3.9.3 Alloyed and heat-treated rail groups

The welding of alloyed rails (wear-resisting grade B, 90 and 110kg/mm² chromium, microalloyed head hardened [MHH] and high performance [HP]), is not permitted without the prior written approval of Network Rails' Senior Technology Engineer (Welding).

A.3.10 Inclement weather

Welding shall be undertaken during inclement weather only when an approved welding tent or umbrella is used for protection.

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A.3.11 Location of repair welds relative to rolling contact fatigue

Arc weld repairs of isolated defects shall not be carried out in rolling contact fatigue (RCF) of any category unless there is at least 100mm of clean rail from the nearest RCF crack and edge of the prepared excavation. Where this requirement is achieved by grinding, this shall be blended over a distance of 1 in 600, eg, for a crack depth of 4mm, the transition shall be a minimum distance of 2.4 metres. Any grinding shall be carried out by the use of approved techniques/procedures and grinding machines only.

On completion of grinding, MPT or LPT shall be carried out to confirm that any RCF cracks have been completely removed prior to commencement of welding.

A.4 NON-DESTRUCTIVE TESTING (NDT) REQUIREMENTS

A.4.1 Operator certification

Welding staff carrying out NDT in conjunction with weld repairs, shall be trained in the use of magnetic-particle testing (MPT) and liquid penetrant testing (LPT) as part of the Network Rail approved training course; MMA 1.

A.4.2 Initial NDT

The ground area shall be inspected visually followed by examination using MPT or LPT techniques.

If there are any defects present following grinding, which exceed the maximum permitted depth specified in the relevant sections of this specification, the welder shall:

- record the details on the relevant welders work return form
- immediately report the details to the person in charge of the work
- weld repair the ground area and restore the rail profile using the welding and profiling techniques prescribed for each process.
- on completion of welding, the rail shall be fitted with emergency fishplates and clamps where this is practicable, prior to the defect being removed within the timescales specified in Table 3.

A.4.3 Completed weld check

On completion of welding, the welder shall carry out a check of the completed weld repair using either MPT or LPT to confirm the absence of surface breaking defects in accordance with the requirements of Table 3. Should any surface breaking defects be found that exceed the requirements of those permitted in Table 3, the welder shall either;

- excavate the defect and re-repair provided that there is sufficient time to do so

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- arrange for the fitting of emergency fishplates and clamps where this is practicable and advise the local Welding Manager to arrange for the weld repair to be removed within the timescales specified in Table 3.

A.4.4 Final weld inspection

Operators carrying out ultrasonic testing of weld repairs shall have been trained and hold a current certificate of competence in accordance with the requirements of NR/SP/TRK/1110.

Weld Inspectors carrying out weld inspection and MPT/DPT of weld repairs shall have been trained and hold a current certificate of competence in accordance with the requirements of NR/L2/CTM/222.

Weld repairs shall be inspected in accordance with the timescales specified below, by the qualified Welding Inspector.

All completed weld repairs shall be examined in accordance with the following requirements:

- **Surface crack detection** - All weld repairs shall be examined by the use of MPT or LPT within one month of completion of welding
- **Volumetric examination** - All weld repairs shall be examined by ultrasonic examination using the U5 technique and are based on the following timescales according to Track Category,
 - Track Categories 1A and 1: within 14 days of completion of welding
 - Track Category 2: within one month of completion of welding
 - Track Category 3, 4 and 5: within 13 weeks of completion of welding
 - Track Category 6: no ultrasonic inspection required.

Exceptions to the above time limits in Track Categories 1A, 1 and 2 may be permitted where access requires special arrangements, but shall not exceed six weeks.

Final weld inspections shall be carried out by persons other than those involved in carrying out the weld repair.

Checks to be made during the final weld inspection shall include profile finish quality.

Details of weld inspection acceptance criteria and those minimum actions required for any non-compliance are contained in Table 3.

Following completion of the final weld inspection, the person carrying out that inspection shall apply a stamp mark to the back edge of the rail head central to the repair. If access to the back edge is restricted by the proximity of a conductor rail, then the stamp mark shall be applied to the centre of the web on the four-foot side of the rail.

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The inspection stamp marks shall indicate acceptance or rejection of the weld as follows:

- 'A' - shall be used to indicate acceptance
- 'R' - shall be used to indicate rejection by the welder
- 'X' - shall be used to indicate rejection by the inspector.

The final weld inspection shall also include the tidiness of the site.

A report shall be completed for each new weld inspected and shall include at least the following items:

- Network Rail Area
- Contract company (if applicable)
- Welder's name
- Welder's stamp number
- Date welded
- Weld inspectors name and signature
- Date inspected
- Defect number if applicable
- Route
- Line
- Rail
- Mileage, including yardage/chainage
- Compliance with this Specification
- Reason(s) for non-compliance (if applicable).

Contractors carrying out weld repairs on behalf of Network Rail shall submit the completed relevant welders work return form to the local Welding Manager within 72 hours of completion of work.

PART B: WELD REPAIR OF PLAIN LINE RAILS

B.1 SCOPE

This part of the specification applies to weld repairs to plain rails in Network Rail managed infrastructure (limits on the applicability of weld repair are specified in Section B.2).

The weld repair techniques covered are MMA and FCAW.

The inspection of weld repairs is included in this part of the specification, together with time-based remedial actions.

B.2 LIMITS OF APPLICABILITY OF PLAIN RAIL WELD REPAIR PROCEDURES

The weld repair of plain rails shall be carried out only on the rail steels and within the limits specified below:

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Wheelburns and Squat-type defects	
Rail steels	R220 grade (BS11 Normal Grade), R260 grade (BS11 wear-resisting grade A), 350MHT (mill heat-treated), AMS.
Rail profiles	All profiles
Max. length of repair	MMA: 200mm ^{1,2} (normal grade group), 125mm ^{1,2} AMS FCAW: 200mm ^{1,2} (normal grade group), 250mm ^{1,2} AMS
Max. width of repair	50mm when defect extends across full rail head (half head width) ³
Max. depth of repair	15mm from crown (red zone), ⁴ 25mm from crown (green zone) ⁴

Notes

1. The maximum lengths specified include the tapered ends at the stop/start positions. Longer defects may be repaired. The 250, 200 or 125mm length shall be completed and ground to profile on each occasion, prior to cutting back into the previously repaired length and continuing to completion.
2. Longer lengths can be repaired when using fully-automatic welding equipment. An assessment of each proposed repair shall be carried out prior to welding taking place by the relevant Senior Maintenance Support Engineer (Welding).
3. If defect extends to full head width, cut back into the head of the rail from the opposite side already repaired to remove fully. Repairs shall always commence on the non-running edge of the rail (see figure 3).
4. If the defect cannot be removed at the maximum specified depth, a temporary repair shall be made, the rail fitted with emergency fishplates and clamps where this is practicable and the rail replaced within 4 weeks.

B.3 GENERAL REQUIREMENTS

B.3.1 Plain rail weld repairs - exceptions and exclusions

Repairs to wheelburns and squat type defects shall not be carried out when the following conditions apply:

- if within 100mm proximity of an aluminothermic weld
- when welding would take place above an insulated joint in CWR¹
- when welding would take place within fishplate limits².

Notes

1. Weld repairs are permitted to wheelburns or squats above dry insulated joints, provided that the joint is dis-assembled prior to welding and that there is no associated vertical defect greater than 15mm present.
2. Weld repairs are permitted to wheelburns and squats within fishplate limits provided that there is no associated vertical defect greater than 15mm deep present. Weld repairs are also permitted to rail end batter in Track Categories 4, 5 and 6.

In both of the above situations, NDT in the form of MPT or LPT is to be carried out on the boltholes prior to and on completion of the weld repair. If it is not possible to

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remove the fishplates (*Note 2*), consideration may be given to carrying out ultrasonic examination using the U1/U2 technique(s).

B.3.2 Tri-metallic zones on AMS crossing leg end extensions

Weld repairs carried out in the vicinity of a tri-metallic zone (TMZ), are subject to the proximity limits shown in Figure 1. However, where defects extend across a TMZ, repairs to these are permitted in accordance with the requirements of section D.4.6.

B.3.3 Initiation of plain rail weld repairs

Before any plain rail weld repairs are carried out, the rail shall be checked for condition of fastenings and these shall be renewed as necessary. The sleeper condition shall be good with an absence of voids. Top, alignment and ballast consolidation shall also be checked, and rectified where necessary.

B.4 WELDING REQUIREMENTS

B.4.1 Requirements for plain rail weld repairs

Plain rail weld repairs shall be carried out either between the passage of trains where the line speed is ≤ 20 mph, or under a planned/published Section T, Part (ii) protection or absolute possession of the line.

If repairs are to be made between the passage of trains, appropriate site-specific lookout protection arrangements shall be made.

B.4.2 Preparation of work

The extent of the repair work required shall be checked, by referring to information provided on the plain line wheelburn and squats summary form, TEF/3001.

The length of defect to be repaired shall be marked on the rail by the welding supervisor and/or the ultrasonic operator as appropriate.

The area to be repaired shall be excavated by grinding (gouging electrodes shall not be used for this purpose) to produce a smooth, bright surface and shall not exceed the maximum dimensions specified in Section B.2. The ends of the repair shall be blended to a 30mm taper to the existing rail surfaces. Light pressure only shall be used when grinding, particularly with AMS, to avoid overheating of the rail.

B.4.3 Welding conditions

When using the MMA process, the welding current shall be set in accordance with the consumable manufacturers' recommendations and the suitability of the current selected, checked by trial depositions on a striking plate, or similar.

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When using the FCAW process, the welding current and voltage shall be set in accordance with the consumable manufacturers' recommendations and the suitability of the current and voltage selected, checked by trial depositions on a striking plate or similar.

In both instances, the striking plate shall not be positioned on any part of the rail.

B.4.4 Deposition techniques

Weld beads shall be deposited as follows:

MMA: Only the stringer bead technique shall be used. The use of the weave technique is not permitted. Weld beads shall be deposited such that they overlap one another by approximately one third.

FCAW: Using a weave technique up to a maximum width of approximately 20mm. Weld beads shall be deposited such that they overlap one another by approximately 25%.

When carrying out welding with the MMA process, weld beads shall be deposited using a technique that will minimise the incidence of start porosity.

Care shall be taken to strike the arc at the intended position on the component to be welded. Stray arcing shall be avoided as cracking of the component may result. The starts, joins and finish position of weld runs shall be staggered across the rail head (see Figure 2).

Where the weld repair is contained within the gauge corners of the rail head, the first weld bead shall be deposited along one of the edges of the excavation. The maximum permitted bead length is specified in section B.2 although longer weld beads are permitted when using fully-automatic welding processes. The second and subsequent weld beads shall then be deposited adjacent to the previous weld bead(s).

The work shall be carried out following the above sequence until the first layer of weld is completed.

Following completion of the first layer of weld metal, subsequent weld layers shall be deposited until there is sufficient weld metal to restore the rail to original profile.

Where the weld repair extends across the full width of the rail, half of the rail head shall be excavated, with the first weld bead being deposited along the non-running edge of the rail. The second and subsequent weld beads shall then be deposited adjacent to the previous weld bead(s) moving inwards towards the centre of the rail head. Sufficient weld beads/layers shall be deposited to restore the rail to original profile. The weld repair shall then be profiled using a rail mounted grinder, prior to the remaining part of the repair being ground back into the previously repaired half from the running edge side of the rail head (see Figure 3). The weld repair shall then

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be completed as previously. The maximum permitted bead length is specified in section B.2.

Weld beads shall be thoroughly cleaned immediately following deposition. All slag must be removed by means of a chipping hammer, hammer and chisel, or needle gun, following which the weld bead shall be cleaned by means of a wire brush. If slag is trapped in the weld metal, or if any other defect occurs, it shall be removed by grinding before welding continues, followed by NDT using either the MPT or LPT technique to confirm removal and the area re-welded.

Any spatter present shall be removed by means of a hammer and chisel.

Where weld repairs extend beyond the maximum permitted dimensions specified in Section B.2, the maximum length of repair shall be completed and the rail ground to profile prior to continuing with the remainder of the defect. When continuing the repair, care shall be taken to grind back into the previous weld repair by 25mm, to remove all defective material.

B.4.5 Inspections during welding

Regular checks of the rail temperature shall be made in accordance with the requirements of section A.3.9. For normal grade rail groups, if the rail temperature should drop below the specified minimum value, further preheating of the rail shall take place prior to recommencement of welding. For AMS, if the temperature exceeds the maximum value, the rail shall be allowed to cool to the required level before welding recommences.

If only one layer of weld metal is deposited onto the surface of the rail, the weld deposition shall be inspected visually for defects. Any visible defects shall be removed by grinding, followed by NDT using either the MPT or LPT technique to confirm removal and the area re-welded.

If more than one layer of weld metal is deposited onto the surface of the rail, then each layer deposited shall provide a smooth and flat surface for deposition of the next layer. Each deposited weld layer shall be inspected visually for defects. Any visible defects shall be removed by grinding and the area re-welded and inspected by use of the MPT or LPT technique.

B.5 WELD FINISHING

B.5.1 Profile grinding

Grinding and re-profiling of the weld repair shall be carried out by the use of an angle grinder where the repair is contained within the gauge corners of the rail head.

Should the repair extend across the full width of the rail head, half of the repair shall be completed and the rail profile restored prior to completing the remaining part of the repair. In both instances, the rail shall be re-profiled using a rail mounted grinder.

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Where weld repairs extend beyond the maximum permitted dimensions specified in section B.2, the maximum length of repair shall be made and the rail profile restored by the use of a rail mounted grinder prior to continuing with the next portion of that repair.

The weld repair shall be allowed to cool to ambient temperature before grinding commences.

Following profile grinding, flatness of the weld repair shall conform to the acceptance criteria specified in Table 3.

B.5.2 Completed weld check by the welder

On completion of welding, the welder shall carry out a check of the completed weld repair in accordance with the requirements of A.4.3.

B.5.3 Final Weld Inspection

Final weld inspection shall be carried out in accordance with the requirements of A.4.4.

B.5.4 Weld identification

All stamps used for the identification of welds, shall be a minimum size of 8mm.

Each contract company carrying out weld repairs on behalf of Network Rail, shall have a unique weld stamp identification mark which shall comprise no more than two alpha characters.

Every welder shall be allocated a unique welder stamp identification number, which shall comprise numeric characters.

On completion of the weld check following profile finishing and before leaving the site, the welder shall stamp all of the welds for which he or she was responsible.

All stamp marks shall be applied to the back edge of the railhead central to the repair. If access to the back edge is restricted (e.g. third rail), the stamp mark shall be applied to the centre of the web on the four-foot side of the rail.

PART C: WELD REPAIR OF SWITCHES

C.1 SCOPE

This part of the specification defines the methods to be used when switch weld repairs are carried out and the permissible limits of weld repairs to sidewear and damage for specific rail steels and switch blade types.

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This part of the specification applies to all flat bottom and bullhead switches in Network Rail managed infrastructure (limits on the applicability of weld repair are set out in section C.2).

The weld repair techniques covered are MMA and FCAW.

The inspection of weld repairs is included in this part of the specification, together with time-based remedial actions.

C.2 LIMITS OF APPLICABILITY OF SWITCH WELD REPAIR PROCEDURES

The weld repair of switches shall be carried out only on the rail steels, rail profiles and switch types, and within the limits of sidewear and damage, shown below:

Details for the weld repair of sideworn switch blades by the MMA and FCAW processes	
Rail steels	R220 grade (BS11 Normal Grade), R260 grade (BS11 wear-resisting grade A).
Rail profiles	BS95 RBH, FB109lb, BS110A & BS113A, CEN54E1A1 & CEN60E1A1
Switch design	Vertical/Inclined, chamfered
Max. length of repair (from switch toe)	Switch type: A - C = 4.5m; D - F = 5.2m
Max. thickness	10mm
Initial NDT	Visual, MPT and/or LPT
Intermediate NDT	Visual (and MPT/LPT as required)
Final NDT	Visual, MPT and/or LPT
Welding position	Horizontal – vertical
Bead length	200mm maximum ¹
Stringer bead	Permitted
Weave	Not permitted
Inclined pad	3 beads maximum at any one time ²

Note 1: Longer lengths can be repaired when using fully-automatic welding equipment. An assessment of each proposed repair shall be carried out prior to welding taking place by the relevant Senior Maintenance Support Engineer (Welding).

Note 2: When using fully-automatic welding equipment, the full depth of the switch blade can be re-surfaced for each inclined weld pad produced.

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Repair of damaged switch blades by the MMA and FCAW processes		
Rail steels	R220 grade (BS11 Normal Grade), R260 grade (BS11 wear-resisting grade A).	LCAMS
Rail profiles	BS95 RBH, FB109lb, BS110A, BS113A, CEN54E1A1 & CEN60E1A1 ¹	FB109lb, BS110A, BS113A
Switch design	Vertical/Inclined, chamfered, straightcut and undercut (bullhead only)	Vertical/Inclined, chamfered, straightcut and undercut (bullhead only)
Max. length of repair (from switch toe)	Switch type: A - H = 2m	Switch type: A - H = 2m
Max. depth	20mm	20mm
Initial NDT - if not previously welded	Visual and MPT	Visual and LPT
Initial NDT - if previously welded	Visual, LPT and MPT	Visual and LPT
Final NDT	Visual and LPT	Visual and LPT
Bead length	200mm max ²	MMA: 125mm max FCAW: 250mm max
Stringer bead	Permitted	Permitted
Weave	Not permitted	Not permitted
Vertical pad	3 beads maximum at any one time	Temperature dependent - shall not exceed 204°C

Note 1: CEN54E1A1 and CEN60E1A1 were respectively known as UIC54B and UIC60B.

Note 2: Longer lengths can be repaired when using semi-automatic FCAW equipment. An assessment of each proposed repair shall be carried out prior to welding taking place by the relevant Senior Maintenance Support Engineer (Welding), particularly if a damaged switch blade is repaired in association with a side worn switch blade subjected to repair using fully-automatic welding equipment.

C.3 GENERAL REQUIREMENTS

This section shall be used in conjunction with the specific procedures for each type of weld repair described in sections C.5 and C.6.

C.3.1 Sidewear repairs - exceptions and exclusions

A sideworn switch blade associated with a sideworn stock rail shall not be weld-repaired in isolation from the stock rail, or in a separate possession.

Note: A sideworn stock rail may be welded using FCAW fully-automatic welding equipment and an approved flux-cored wire.

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C.3.2 Initiation of switch weld repairs

The requirement for weld repair will normally be triggered by the outcome of a detailed inspection in accordance with the requirements of NR/L2/TRK/0053, Inspection and repair procedures to reduce the risk of derailment at switches.

The Network Rail representative shall be responsible for ensuring that a thorough inspection of the switch is carried out using the detailed information on the 053 form to establish those weld repairs required, no greater than 7 days prior to the commencement of work. The person carrying out the inspection, shall be trained and competent in accordance with the requirements of NR/L2/TRK/0053.

Details of the work required shall be entered onto the welders work return form, TEF/3008 - switch repairs, and forwarded to the welder carrying out the work prior to the work commencing.

C.3.3 Responsibilities

The Network Rail representative shall be responsible for ensuring that:

- the clearance between the front stretcher bar kicking strap and the stock rail is at the design clearance minimum of 3mm before any weld repairs are commenced
- the area of the switch to be repaired is thoroughly cleaned immediately prior to the commencement of weld repair using a suitable degreasing agent. It is essential that all grease and lubricants are removed to prevent fumes
- before any switch weld repairs are carried out, the switch shall be fettled with all fastenings and fittings checked, renewed (as necessary) and tightened. The timber/bearer condition shall be good with an absence of voids.

At the initial site visit the switch and stock rails shall be inspected for rail defects which would necessitate replacement of the switches (see NR/L2/TRK/0053).

Any special precautions to protect the switch drive equipment, electric heating equipment etc., during welding operations shall be established.

C.3.4 Requirements for switch weld repairs being carried out in situ

Switch weld repairs shall be carried out only under an absolute possession of the line in accordance with Railway Group Standard GO/RT3000, Section T (Part iii) or under planned/published Section T (Part ii) arrangements.

Work on power-operated points shall be undertaken only in accordance with Railway Group Standard GO/RT3000, Section F (Part i).

Arrangements shall be made for the appointment of personnel to be in attendance, normally at the completion of the work, in order that the correct detection criteria and switch blade settings may be confirmed. Confirmation of the correct settings shall be determined only by personnel suitably qualified and certificated to undertake these

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duties. If their appointment/attendance cannot be confirmed the work shall not be commenced.

C.3.5 Preparation of work

The switch components and baseplates within the area to be repaired shall be thoroughly cleaned using a suitable degreasing agent.

The extent of the repair work required shall be checked, by referring to information provided on the welders work return form, TEF/3008 - switch repairs.

The lengths to be repaired shall be marked on the switch blade and stock rail as appropriate.

The seating condition of the switch blade in the closed position shall be checked at each slide baseplate and the details recorded.

The clearance between the top of the front stretcher bar kicking strap and the stock rail, with the switch blade in the closed position, shall be checked and recorded. If the clearance is not within the minimum 3mm tolerance the switch weld repair shall not be commenced.

The requirements of the previous two paragraphs are to be carried out using a tapered or stepped gauge and recorded to the nearest millimetre.

In the case of sidewear repairs the angle of sidewear shall be checked at each timber or bearer position throughout the length to be repaired and at a position 100mm clear of the proposed finish of the repair. These details shall be recorded on the welders work return form, TEF/3008 - switch repairs.

Before the commencement of any grinding operation protective covers shall be positioned to protect any unprotected switch drive and electric heating equipment, cables etc. Where dry slide baseplates are in use the inserts shall be removed before work commences and replaced only when all welding and grinding operations have been completed.

All lipping shall be removed, by grinding, from both the switch blade and stock rail.

The area to be repaired shall be lightly ground to produce a smooth and bright surface, and blended gradually to the existing rail surfaces at each end, followed by NDT using either MPT or LPT to confirm the absence of defects.

C.3.6 Welding conditions and requirements

When using the MMA process the welding current shall be set in accordance with the consumable manufacturers' recommendations and the suitability of the current selected, checked by trial depositions on a striking plate, or similar.

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When using the FCAW process, the welding current and voltage shall be set in accordance with the consumable manufacturers' recommendations and the suitability of the current and voltage selected, checked by trial depositions on a striking plate or similar.

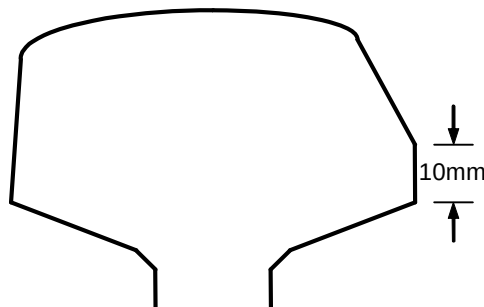
In both instances, the striking plate shall not be positioned on any part of the rail.

Switch blades shall be welded only in the open position.

Welding of stock rail fronts shall not be carried out within 100mm of an aluminothermic weld, or RCF.

Welding of a stock rail behind the switch blade is permitted only where it is accessible for welding and profiling for 2m maximum from the switch toe. Welding of stock rails is not permitted when the sidewear on the stock rail behind the switch blade extends beyond 2m from the switch toe.

Where a stock rail requires welding, the work shall be carried out only where there is a minimum of 10mm remaining on the running edge measured from the bottom corner of the rail head, as depicted below.



C.3.7 Deposition techniques

Welding shall commence at the point nearest to the switch toe working gradually towards the heel.

Unless otherwise permitted straight stringer bead depositions shall be made at all times.

In order to control distortion, the method of repair, order and length of weld bead depositions prescribed for each weld repair procedure shall be followed.

Care shall be taken to strike the arc at the intended position on the component to be welded. Stray arcing shall be avoided as cracking of the component may result.

Weld beads shall be thoroughly cleaned immediately following deposition. All slag shall be removed by means of a chipping hammer, hammer and chisel or needle gun, following which the weld bead shall be thoroughly cleaned by means of a wire brush.

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If slag is trapped in the weld metal, or if any other defect occurs, it shall be removed by grinding before welding continues. Total removal shall be confirmed by the use of MPT and/or LPT.

Any spatter present shall be removed by means of a hammer and chisel.

Welding shall continue until sufficient depositions have been made to enable the correct profile to be restored.

C.3.8 Inspections during welding

Vertical distortion of the switch blade shall be checked frequently during weld repair. The checks shall be made with the switch blade closed against the stock rail.

If only one layer is welded on any surface of the rail the weld deposition shall be inspected visually for defects. Any visible defects shall be removed by grinding, followed by NDT using either the MPT or LPT technique to confirm removal and the area rewelded.

If more than one layer is to be welded on any surface of the rail then each layer whether inclined or flat shall be ground until all crevices are removed and the surface is smooth. The ground layer shall be inspected visually for defects. Any visible defects shall be removed by grinding, followed by NDT using either the MPT or LPT technique to confirm removal and the area rewelded, prior to being ground and inspected visually for defects before the next layer is welded.

In the event that any defects have to be removed by grinding from this re-welded area the area shall be checked by use of the MPT or LPT technique following removal of the defect.

C.4 WELD FINISHING

C.4.1 Profile grinding

Grinding of the back edge and gauge corner of a switch blade shall be carried out by the use of an angle grinder.

Grinding of the top running surface of a switch blade shall be carried out by the use of an angle grinder or other means approved by Network Rail.

Grinding of the running edge of a switch blade shall be carried out by use of an approved and fully supported switch grinder:

- the full length of the repaired area shall initially be ground to remove excess material and produce a rough profile
- following initial grinding the switch blade shall be restored to the required profile
- grinding should be contained in short lengths working from the switch toe towards the heel.

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During all grinding operations frequent checks shall be made using the appropriate approved gauges, to enable the correct profile to be restored on the switch blade.

Care shall be taken during all grinding operations to avoid any undue force or pressure being applied to the abrasive wheel.

Grinding of the switch blade shall be carried out only with the switch blade in the open position.

C.4.2 Blending into existing profile

When a weld repair is carried out resulting in different gauge face profiles, the existing most worn profile shall be blended into the weld repair. Blending shall be carried out as follows:

- the switch grinder shall be set so as to reproduce the most worn profile
- the weld repair shall be ground such that the ground length of the most worn profile angle, shall always have the same angle as the area immediately adjacent to the weld repair. The blended length shall always be 1.5m
- the angle shall be checked throughout the blended length and details recorded.

C.4.3 Final weld inspection

The repaired area shall be inspected visually and by use of the MPT and/or LPT technique as soon as the component has cooled to ambient temperature.

Any defects found shall be removed by grinding and the area affected re-welded following which a further inspection shall be made using the MPT and/or LPT technique. The finished repair shall not exhibit any defects and this shall be taken to include undercutting and incomplete welding or notches. There shall be no overhang or overlap of weld metal at the lower level of the repair.

The switch tip height and repairs to damaged switch blades shall be checked by use of the switch wear gauge conforming to RE/PW/429.

The gauge corner radius on a switch blade shall be checked by use of the S&C maintenance gauge conforming to RE/PW/425 or the switch blade radius gauge conforming to RE/PW/430.

The restored switch blade angle and any blending that may have been necessary shall be checked by use of the switch blade angle gauge conforming to RE/PW/436.

C.4.4 Site checks before re-opening line to traffic

On completion of all welding operations the switch blade shall be moved over to abut the stock rail.

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The Network Rail representative shall check that all weld repaired switches are assessed for the correct and safe fit of the switch blade to the stock rail.

The Network Rail representative shall inspect the site to establish that all of the switch components and equipment are in good working order. Any necessary remedial action shall be taken, or arranged before normal running is resumed.

All switch weld repairs are to be inspected on completion by a person trained and competent in accordance with the requirements of NR/L2/TRK/0053. The inspection shall include a facing points locking test and inspection in accordance with the requirements of NR/L2/TRK/0053. If failure of either of these examinations occur, further remedial work shall be carried out if time permits or the signaller shall be contacted to determine which direction the points shall be locked out of use.

All necessary details are to be recorded on the welders work return form, TEF/3008 - switch repairs.

The welder shall leave the site in a safe and tidy condition.

C.4.5 Site checks after re-opening line to traffic

Following passage of service traffic, a follow up inspection in accordance with the requirements of NR/L2/TRK/0053 shall be carried out within the timescales specified.

All necessary details are to be recorded on the welders work return form, TEF/3008 - switch repairs.

C.5 PROCEDURE FOR THE REPAIR OF SIDEWORN SWITCH BLADES BY THE MMA AND FCAW PROCESSES

These procedure details shall be used in conjunction with Section C.3.

C.5.1 Inspection requirements

Following the initial grinding of the switch blade or stock rail in readiness for welding, the component shall be inspected in accordance with the procedure details for weld repair of sidworn switch blades described in section C.5.2.

C.5.2 Deposition and inspection techniques

Sidworn switch blades shall be weld repaired with the commencement always being at the end nearest to the toe. Welding shall always be in the direction from the toe to the heel of the switch blade.

C.5.2.1 MMA and semi-automatic FCAW processes

Weld beads shall be deposited in the following sequence:

- the first weld bead shall be deposited at the lowest required level of the face of the switchblade. The maximum permitted bead length is 200mm

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- the second weld bead shall be deposited, immediately above the first deposition, ensuring that the start and finish take a diagonal form
- the third weld bead shall be deposited immediately above the second deposition, ensuring that the start and finish take a diagonal form.

The start of weld beads associated with the switch tip shall be the only exception to the requirement to take a diagonal form.

In order to control distortion of the switch blade, following the third deposition welding shall be continued at the lowest level of the switch blade commencing at the finish of the first deposition, with two subsequent weld beads deposited as described above. Welding shall continue in this manner until a length of 1m of the prepared area has been welded with three depositions high.

Welding shall recommence at the toe end of the repair where a maximum height of up to a further three depositions shall be made as may be necessary.

The work shall be carried out in this sequential manner until the first metre of repair is completed.

The kicking strap clearance and switch blade seating condition shall be checked with the switch blade in the closed position. If the switch blade has risen or is likely to rise off the front slide baseplate by 6mm then work shall cease and any necessary precautions put into force.

If the kicking strap clearance and seating condition is satisfactory then work shall be commenced on the second 1m length, or part thereof.

Following completion of the first metre of weld repair, welding shall continue in a sequential manner as specified in the previous paragraphs in multiples of up to a maximum length of 1m at any time, until the entire repair length is completed.

From the commencement of welding the second 1m length, constant attention shall be given to the seating condition on the front slide baseplate and the kicking strap clearance, in accordance with the parameters indicated previously. Checks of these conditions shall be carried out at intervals as may be deemed necessary, but not exceeding each repair length of 1m with a deposition height of three weld beads.

C.5.2.2 Fully-automatic welding equipment

Side wear repairs carried out with fully-automatic welding equipment shall follow the same general principles of C.5.2.1 but with the following exceptions;

- preheating of the switch blade shall be carried out using the extended switch rail heater with both the top and bottom heaters employed
- the switch blade shall be preheated to 343°C initially at which point the top burner shall be turned off and welding allowed to commence. Welding shall continue at an interpass temperature of between 302-343°C, but should the temperature drop below 302 °C, welding shall be terminated and the top

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burner re-ignited. The switch blade temperature shall be restored to 343°C before welding is allowed to recommence

- the maximum permitted weld bead length shall be 650mm maximum
- the full depth of the switch blade can be re-surfaced for each inclined weld pad deposited until the entire repair length is completed.

C.6 PROCEDURE FOR THE REPAIR OF DAMAGED SWITCH BLADES BY THE MMA AND FCAW PROCESSES

These procedure details shall be used in conjunction with section C.3.

C.6.1 Inspection requirements

Following the initial grinding of the switch blade in readiness for welding, that component shall be inspected in accordance with the requirements of the procedure for repair of damaged switch blades described in section C.6.2.

C.6.2 Deposition and inspection techniques

Damaged switch blades shall be weld repaired with the commencement being at the end nearest the switch toe. Welding shall always be in the direction from the toe to the heel of the switch blade.

Where a section of the damaged blade is lower than the level of the surrounding area, then that section shall be weld repaired to restore it to the same level before continuing as above.

When repairing damage in association with a side worn switch, the damage shall be repaired prior to commencement of repairing the side wear. When carrying out repairs to side worn switches with fully-automatic welding equipment, the damage shall initially be repaired using the semi-automatic FCAW process.

The maximum permitted bead lengths shall be in accordance with the requirements of the procedure for repair of damaged switch blades described in section C.6.2.1.

C.6.2.1 *Welding on rail steels other than low carbon AMS (LCAMS)*

When welding with the MMA and FCAW processes, only the stringer bead technique is permitted.

Weld beads shall be deposited in the following sequence:

- a maximum of three weld beads shall be deposited in the first 200mm length
- welding shall continue with up to a maximum of three weld beads being deposited in each subsequent 200 mm length up to a maximum length of 1m
- if further welding is necessary within the 1m length then it shall be commenced at the end nearest to the toe with up to a maximum of three depositions in that and each subsequent 200mm length