

Technical specification

T0432

Installation, Inspection and Reporting of Alumino-thermic Welding



**Please read the Written Notices
attached to this standard**

Issue No.: A3

Issue date: May 2014

Review date: May 2017

MAYOR OF LONDON

AVA Documents
Document Sharing Hub



Contents

1	Purpose	3
2	Scope	3
3	Requirements	3
3.1	Appointment of Rail Manager and Designated Manager	3
3.2	Use of approved welding processes, materials and equipment	3
3.3	Training, Certification and Assessment of Inspectors, Welders and Assistants	3
3.4	Records of personnel and stamp numbers	4
3.5	Installation	4
3.6	Weld inspection and stamping by Track Welder	8
3.7	Final weld inspection and stamping by Track Welding Inspector	9
3.8	Actions for rejected welds	10
3.9	Record of weld inspection	10
3.10	Record of installed welds	10
4	Responsibilities	10
4.1	Rail Manager	10
4.2	Designated Manager	11
4.3	Welding Contractors	11
4.4	Assessors	11
5	References	12
5.1	References	12
5.2	Abbreviations	12
5.3	Definitions	12
5.4	Person accountable for the document	13
5.5	Document history	13
6	Attachments	13
6.1	Attachment 1 – Typical Inspection Form (for use by Weld Inspector)	15
6.2	Attachment 2 – Alignment tolerances	17
6.2	Attachment 2 – Alignment tolerances	18
6.3	Attachment 3 – Measuring weld Alignment	19
6.4	Attachment 4 – Collar Alignment Tolerance	22
6.5	Attachment 5 – Weld Location Chart	23
6.6	Attachment 6 – Bolt Hole Position	26
6.7	Attachment 7 – Weld Inspection and Acceptance Criteria	27
7	Current Written Notices attached to this Technical Specification	29

1 Purpose

1.1 The purpose of this specification is to set out LU's requirements for alumino-thermic welding of rail, in respect of

- a) Training and certification of welding personnel;
- b) Approval of welding processes;
- c) Weld installation;
- d) Weld inspection and recording.

2 Scope

2.1 This specification covers rails of 95RBH and 56E1 (113A) profiles as defined in BS 11 and EN 13674-1 respectively. It covers grades R220 and R260 as defined in EN 13674-1.

3 Requirements

3.1 Appointment of Rail Manager and Designated Manager

Competent persons shall be appointed to undertake the roles of Rail Manager and Designated Manager, with the responsibilities set out in this document and specifically in clauses 4.1 and 4.2 respectively.

3.2 Use of approved welding processes, materials and equipment

- 3.2.1 Only processes approved by LU may be used on LU infrastructure. Processes shall be approved according to EN 14730-1.
- 3.2.2 The primary documentation for the installation of alumino-thermic welds shall be the Process Supplier's manual.
- 3.2.3 Selection, assembly, care and use of equipment for alumino-thermic site welding, oxy-fuel gas cutting and pre-heating processes shall be carried out in accordance with the Process Supplier's manual.
- 3.2.4 All oxy-fuel gas equipment shall be purchased, registered, tested and maintained in accordance with the recommendations found in the British Gases Code of Practice and the Process Supplier's manual.

3.3 Training, Certification and Assessment of Inspectors, Welders and Assistants

- 3.3.1 Contractors undertaking alumino-thermic welding duties and final weld inspection shall have approval of LU.
- 3.3.2 Contractors undertaking alumino-thermic welding duties and final weld inspection for LU must be able to produce current certification as having welding or inspection capability.
- 3.3.3 Only Track Welders and Trainee/Assistant Welders who have been trained by the process supplier or their appointed agent, or at a training centre approved by LU, and are in possession of appropriate and current certification of competence shall be permitted to carry out welding duties.
- 3.3.4 Trainee/Assistant Welders shall have a minimum of 15 days' training to achieve the necessary competence to be certificated to undertake the duty of Welder's Assistant.



- 3.3.5 The duty of Welder's Assistant shall be undertaken for a period of at least 6 months before welder conversion training can commence in Railtech or Thermit processes.
- 3.3.6 The conversion training modules shall be a minimum of 20 days for the Thermit process and 15 days for the Railtech process.
- 3.3.7 Upon successful completion of conversion training, individuals shall be certificated to Trainee Welder in the relevant process. The certificate shall be valid for one year.
- 3.3.8 Trainee Welders shall complete at least 20 shifts of welding (assisting in the production of at least 10 welds with similar wear, 10 welds with dissimilar wear and 2 wide-gap welds) during a six month period while working with an experienced Track Welder. After this period, subject to satisfactory performance and work quality, Trainee Welders shall be assessed in the workplace and if successful may be certificated as Track Welder in the skills and processes in which competence has been demonstrated.
- 3.3.9 Assessment of Track Welders and Assistant Welders shall be carried out at 12 monthly (± 1 month) intervals by an occupationally-competent assessor, who shall record the assessment in the competence management system. These assessments shall comprise alternating in-track and out-of-track assessments, each carried out 24-monthly.
- 3.3.10 Recertification of all welding personnel shall be carried out at a training centre approved by LU and at intervals not exceeding 24 months.
- 3.3.11 Only Track Welding Inspectors who are in possession of the appropriate and current certification shall be permitted to carry out inspection duties.
- 3.3.12 Training in the use of powered plant shall be carried out at a training centre approved by LU.

3.4 Records of personnel and stamp numbers

- 3.4.1 Welding contractors and Track Welders shall be issued with unique personal stamp numbers. Track Welding Inspectors shall be issued with unique personal stamp numbers if they carry out welding.
- 3.4.2 The stamps shall be a minimum size of 8mm.
- 3.4.3 A list of all Track Welders and Track Welding Inspectors and their stamp numbers shall be forwarded to LU's Designated Manager by the welding contractor prior to the commencement of track welding on LU's infrastructure.

3.5 Installation

3.5.1 Tunnel locations

Alumino-thermic welding shall be carried out in tunnel locations only when the arrangements pertaining to the prevention of fire and the control and dispersion of smoke are in place to safeguard personnel and assets and to prevent loss of service.

3.5.2 Weather considerations

- 3.5.2.1 During inclement weather such as snow, rain or drizzle, welding shall only be carried out under cover. The dryness at all times of alumino-thermic welding equipment and portions is essential to safety and to the making of good welds.
- 3.5.2.2 The precautions detailed in sections (a) and (b) below shall be taken when alumino-thermic welding is carried out at rail temperatures below 0C.



- a) The luting sand shall be checked to ensure that it is not frozen before commencing luting operations.
- b) Precautions shall be taken to ensure that regulators and cylinders do not freeze up and cause a sub-standard weld due to reduced gas flow.

3.5.3 Identification of rail

3.5.3.1 The rail steel shall be correctly identified prior to welding to enable selection of the correct welding technique and alumino-thermic portion.

3.5.3.2 Rail can be identified by rolled markings. If rail cannot be identified, welding shall not commence.

3.5.4 Site evaluation and preparation

3.5.4.1 The following track conditions shall be as specified in S1159 prior to welding:

- a) Rail alignment;
- b) Ballast condition;
- c) Sleeper spacing;
- d) Condition of sleepers and rail fastenings.

3.5.4.2 Welding is permitted between sideworn and unworn rails, and between rails with different sidewear, regardless of direction of traffic. See clause 3.5.10.7 for requirements regarding the blending of any differential sidewear.

3.5.5 Location of welds relative to other features

3.5.5.1 The limits in Attachment 5, regarding weld location in rail, shall be observed.

3.5.5.2 Welds shall be located nominally centrally between sleepers. If necessary the weld may be located off-centre but not closer than 75mm to any chair, baseplate or concrete sleeper.

3.5.6 Rail-end preparation

3.5.6.1 Welding of bolted joints (i.e. to convert them to previously-bolted welded joints, PBWJs) is permitted as follows:

- a) Where both rails are new and of the same profile, and the joint has carried traffic for no more than seven days, there are no specific requirements and the rail ends need not be cropped;
- b) Where the rails are of the same profile, and the joint has carried traffic for more than seven days, it may be welded subject to the following requirements:
 - i. the joint shall not be the closing weld for rail stressing;
 - ii. the joint dip shall not exceed 2mm and there shall be no voiding present;
 - iii. there shall be no batter on either rail end sufficient to preclude ultrasonic testing;
 - iv. there shall be no discernable bolt-hole elongation;
 - v. an ultrasonic inspection carried out no sooner than seven days before welding shall show no defects;
 - vi. a dye penetrant or magnetic particle inspection of the rails within the fishplate limits, including the rail end faces, carried out within the seven days before welding shall show no defects (if the rail end faces of a tight joint cannot be tested in advance, they shall be mechanically cut immediately prior to welding to allow this testing);
 - vii. the rail ends shall each be mechanically cropped a minimum of 6mm (but retaining not less than 30mm between the cut rail end and the nearest bolt hole);



- c) In cases other than (a) and (b) the rail ends shall be cropped 50mm beyond the ends of the fishplates (this will require some spare rail to be available on site).

3.5.6.2 Following welding of a previously-bolted joint the following actions shall be carried out:

- a) any remaining bolt holes shall be cold-expanded after the weld has cooled, within 24 hours of making the weld and before it is independently inspected;

Note 1: The effect of any previous cold-expansion is considered to be lost when welding is carried out.

Note 2: If the holes have been previously cold-expanded there will be nibs projecting into the holes. The holes will need to be re-cut so that the correct mandrel can be selected and the cold-expansion carried out effectively.

- b) the sleepers each side of the joint shall be consolidated;
- c) the welding of the joint shall be recorded in a register of PBWJs, including a photograph;
- d) ultrasonic inspection using the U6a procedure shall be carried out at the normal U1/U2 frequency for the section of line.

3.5.6.3 If rail ends have to be repositioned to achieve the correct alignment, fastenings shall be slackened off and approved alignment devices used.

3.5.6.4 The rails shall be aligned so that when checked with a one metre straight edge the vertical level and straightness of alignment on completion of the weld shall be within the limits specified in Attachment 2. Where it is not possible to meet these requirements the rails shall be cropped and a closure rail inserted.

3.5.6.5 Alignment of welds produced line-side must be undertaken by use of an approved alignment beam or device.

3.5.7 Welding gap and cutting of rails

3.5.7.1 The welding gap for each type of weld shall be according to the Process Supplier's manual.

3.5.7.2 When tensors are used the initial rail gap shall equal the calculated stressing gap plus the welding gap.

3.5.7.3 The welding gap shall be produced by adjusting the rails or by cutting the rail ends as detailed below.

3.5.7.4 Where possible, rails shall be cut using a power assisted saw or abrasive disc. However, mechanical cutting of stressed rails is prohibited: the first cut into such rails shall be by flame-cutting.

3.5.7.5 Free-hand flame-cutting of rail is prohibited. Flame-cutting shall only be carried out using an LU-approved cutting guide.

3.5.7.6 The rail ends shall be cut square and vertical to within 2mm both vertically and laterally.

3.5.7.7 The rail ends shall be cleaned to remove burrs, dirt, grease and rust.

3.5.7.8 After the rail ends have been aligned, datum marks shall be made on rails and associated sleepers and regularly inspected during welding to detect longitudinal movement in the rails. Welding shall cease, and the necessary correction be made, if longitudinal movement causes the gap to exceed the tolerances permitted by the Process Supplier's manual.



3.5.8 Pre-heating

- 3.5.8.1 Preheating shall be in accordance with the Process Supplier's manual.
- 3.5.8.2 Preheating shall be maintained without any alteration throughout the whole preheating cycle.
- 3.5.8.3 If any alteration is necessary, the preheating shall be terminated, the moulds removed and the rails allowed to cool naturally to below 50C. The welding of the joint shall commence only when the required temperature has been achieved and checked with a suitable temperature-indicating system.

3.5.9 Further requirements regarding use of tensors

- 3.5.9.1 Only trained and certificated persons shall install and operate tensors.
- 3.5.9.2 The use of abrasive saws between tensors is prohibited.
- 3.5.9.3 At least 40m of rail on each side of the tensors shall be fastened down prior to welding.
- 3.5.9.4 To avoid the risk of hot tears the tensors shall remain in position after the completion of the pour with the weld under pressure. The pressure and time shall be as specified in the Process Supplier's manual; however, the time shall not be less than 30 minutes for standard-gap welds and 50 minutes for wide-gap welds.
- 3.5.9.5 If a tensile load is applied to the weld it shall be cut out and the rail re-welded.

3.5.10 Weld finishing

- 3.5.10.1 The weld shall be trimmed using an LU-approved trimming tool, no earlier than as stipulated by the Process Supplier.
- 3.5.10.2 No earlier than 30 minutes, or any longer time stipulated by the Process Supplier, after completion of the pour the weld shall be ground to match the rail head profile of the main body of the rail.
- 3.5.10.3 The method of final profile grinding shall be subject to approval by LU.
- 3.5.10.4 During final profile grinding, frequent checks shall be made using a one metre straight edge to ensure that the top and alignment tolerances are as detailed in Attachment 2.
- 3.5.10.5 There shall be no upward step in either direction.
- 3.5.10.6 Welds between rails of different head profiles (excluding sidewear) shall be ground so that the head profiles are blended over a minimum distance of 1.5 m from the weld.
- 3.5.10.7 Trains are permitted to run from a sideworn rail to an unworn or less sideworn rail, or vice-versa, only when the difference between the two rails has been blended into the less sideworn rail. The sidewear gradient shall not exceed 1mm per 600mm along the rail. The minimum length of blending shall be 1.5m from the weld and a fully supported grinder must be used to maintain the angle of sidewear throughout the blended length.
- 3.5.10.8 In an emergency a train may be permitted to pass over a weld trimmed by hydraulic shears but which has not been ground, at a maximum speed of 5 mph. However, the specified time for the removal of the wedges shall still be observed, and the track shall have been fettled before running of the train is permitted.
- 3.5.10.9 All welds shall be suitably cleaned to facilitate inspection.
- 3.5.10.10 The surrounding area shall be left clean and tidy.



- 3.5.10.11 The completed weld shall be painted white with the paint placed beside, not directly upon, the weld. Where a bolted joint has been welded without cropping of the bolt-holes the paint shall extend over the fishplate limits, but excluding the weld itself.
- 3.5.10.12 Where a bolted joint has been welded without cropping of the bolt-holes arrangements shall be made for the following to be undertaken:
- a) a minimum of two sleepers each side of the weld shall be packed within 24 hours;
 - b) redundant bolt holes shall be cold-expanded within 24 hours;
 - c) the weld shall be ultrasonically inspected using the U6a procedure at the normal U1/U2 ultrasonic inspection frequency for that section of line.

Note: The U6a procedure is described in Tube Lines document WI-7283.

3.6 Weld inspection and stamping by Track Welder

- 3.6.1 Trains shall not be allowed to pass over a weld until it has been examined and passed as satisfactory by the Track Welder or mitigation has been agreed between the Track Welder and the Site Person in Charge and implemented.
- 3.6.2 Track Welders shall visually inspect the completed weld to ensure no visible defects are present and complete a Worksite Report Form. The report shall state as a minimum:
- a) Name and stamp number of the Track Welder.
 - b) Track Welder's Employer.
 - c) Weld location (line, metreage, rail).
 - d) Date and time of weld.
 - e) Initial inspection results.
 - f) If the weld was installed in wet conditions what level of cover was attained.
 - g) Any sub-standard conditions occurring during installation.
- 3.6.3 Within 24 hours of completion of their shift the Track Welder shall pass the completed report to the appropriate Track Manager or Supervisor responsible for the work on that section of track.
- 3.6.4 If the weld has been installed correctly the Manager or Supervisor shall pass the completed installation report to the Welding Inspector. A copy shall be retained for audit purposes.
- 3.6.5 All welds are to be permanently marked by die-stamping in the web of the rail on the four-foot side. The Track Welder's unique stamp numbers shall identify both the Welding Contractor and the Track Welder.
- 3.6.6 In addition to the Track Welder's identification stamp, welds shall be stamped with the following letters as appropriate:
- T for welds made between hydraulic tensors
 - L for welds made out of track
 - R for welds which have been rejected by the Welder; the use of this stamp includes the situation where a weld is made in rain or snow without suitable umbrella or tent protection.
- 3.6.7 The final part of the stamp mark shall be the last two digits of the year in which the weld was installed, e.g. stamp 14 for year 2014.



- 3.6.8 If, during the Track Welder's inspection, defects are found to be present the Track Welder shall, where time permits, replace the weld before the line is opened to traffic. Otherwise he shall:
- a) stamp the weld 'R'
 - b) arrange for the weld to be clamped;
 - c) report the circumstances to the T002/3 competent person and the Site Person in Charge, who will arrange for any necessary speed restriction to be imposed.
- 3.6.9 A defective weld shall be treated as a cracked or broken rail for the purposes of reporting and investigating.
- 3.6.10 Where a defective weld is removed from track, it shall be retained for further evaluation and metallurgical examination. The Designated Manager shall complete a rail defect form and send it to the Rail Manager who shall enter the details on to the rail defect database.

3.7 Final weld inspection and stamping by Track Welding Inspector

- 3.7.1 Final weld inspection shall be carried out on all alumino-thermic welds within one calendar month of installation. If inspection is not possible within this period the weld shall be clamped within 24 hours and inspection arranged within 48 hours.
- 3.7.2 The inspection shall be carried out by a Track Welding Inspector independent of those involved in the installation of the weld.
- 3.7.3 The Track Welding Inspector shall ensure that all welds have been identified with the Track Welder's unique identification stamp before inspection is carried out.
- 3.7.4 Visual inspection of the weld surface shall be carried out to confirm the absence of:
- a) Cracks of any description.
 - b) Surface cavities and/or inclusions penetrating into the rail surface greater than 1mm.
 - c) Porosity and surface cavities penetrating into the surface of the rail.
 - d) Cavities in the vent riser (black holes) penetrating more than 5mm into the reinforcing of the weld collar.
 - e) Oxidisation above rail foot
 - f) Incomplete or distorted weld collar. Note that:
 - No distortion under the foot is permissible.
 - Glazing under the foot is permissible if it does not extend for more than 30mm each side of the centre line of the weld.
 - Surface damage within 100mm of the weld greater than 1mm is not permitted.
- 3.7.5 The straightness of the joint shall be measured in accordance with Attachments 2 and 3.
- 3.7.6 The alignment of the collar shall be measured in accordance with Attachment 4.
- 3.7.7 There shall be no welds or fish-plated joints including insulated joints within 4.5 metres of the weld (except where a concession has been granted).
- 3.7.8 There shall be no boltholes, bond holes or scars, wheel burns, rolling contact fatigue or chair gall within the specified limits in accordance with Attachment 5, which is the weld location chart.
- 3.7.9 On completion of the inspection the Track Welding Inspector shall stamp the weld:

'A' if it meets the inspection criteria.

'X' if it fails to meet the inspection criteria and can only be rectified by removal.

3.7.10 Where the weld requires rectification, the Designated Manager shall ensure that the work is carried out within the correct timescale (Attachment 7). The Track Welding Inspector shall not counter-stamp the weld until the rectification work has been completed and he has re-inspected the weld; he shall then stamp the weld "A" or "X" as appropriate.

3.7.11 Where the weld requires removal, the Designated Manager shall make arrangements for the weld to be clamped immediately and the weld removed within the required timescale. A defect report shall be sent to the Rail Manager as described in clause 3.6.9.

3.8 Actions for rejected welds

Any non-compliance with this standard found during the post-welding or final inspection shall be subject to minimum actions described in Attachment 7 (Weld inspection and acceptance criteria).

3.9 Record of weld inspection

3.9.1 Each weld inspection shall be recorded.

3.9.2 If a failed weld has been rectified to the Track Welding Inspector's satisfaction, the Inspector shall counter-stamp the weld "A" and endorse the original report. The Track Welding Inspector shall forward a copy of the endorsed report to the Welding Contractor and the Designated Manager.

3.10 Record of installed welds

The Designated Manager shall maintain a complete record of all alumino-thermic welds installed and inspected. The Rail Manager shall review the record regularly to ensure the weld details are properly maintained.

4 Responsibilities

4.1 Rail Manager

The Rail Manager shall:

- a) approve and maintain a list of the Welding Contractors. A register of their competent Track Welders shall be maintained in conjunction with the Designated Manager;
- b) audit Welding Contractors and LU's welding organisation annually in respect of welding management, including installation and inspection;
- c) review the weld database on a regular basis to ensure it is properly maintained;
- d) provide technical leadership and support to LU's welding and asset performance managers;
- e) make every effort to introduce improved products and processes.