

## **E.10/7 : FIELD WELDING OF RAIL JOINTS**

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## 1. SCOPE

This specification covers the work necessary for joining rails by field welding of rail joints in the track.

## 2. INTERPRETATIONS

### 2.1 SUPPORTING SPECIFICATIONS

2.1.1 Where this specification is required for a project, the following specifications, shall, inter alia, form part of the contract documents:

- a) The E.10 Gen - General.
- b) The E.10/8 - Field welding and corrective grinding of battered rail joints skid marks and rail crown damage.
- c) Spoornet's Track Welding Specifications SSS-5, SSS-6 and SSS-11.

2.1.2 In addition the following specifications, inter alia, may be required:

- a) The E.10/1 - Laying of rails.
- b) The E.10.2 - Laying of sleepers.
- c) The E.10/4 - Ballasting and tamping
- d) The E.10/5 - Destressing of rails.
- e) The E.10/9 - Slewing and alignment.

### 2.2 DEFINITIONS

Void.

## 3. MATERIALS

3.1 Welding materials shall comply with the specifications or be of the manufacture shown in the following list.

- |       |  |                     |
|-------|--|---------------------|
| (i)   | Gaseous oxygen in cylinders -          | CKS 50.             |
| (ii)  | Dissolved acetylene in cylinders -     | CKS 169.            |
| (iii) | Liquified petroleum gas in cylinders - | SABS 690.           |
| (iv)  | Welding rods and flux core wire -      | Spoornet's PWM 2/13 |
| (v)   | Aluminothermic welding kits -          | Spoornet's PWM 2/13 |
| (vi)  | Long life crucibles -                  | Spoornet's PWM 2/7  |
| (vii) | Aluminothermic heating blocks -        | Spoornet's PWM 2/8  |

(viii) Cutting disks - as approved by the Engineer.

(ix) Grinding stones - as approved by the Engineer.

#### 4. PLANT

Void.

#### 5. CONSTRUCTION

##### 5.1 GENERAL

Void.

##### 5.2 SAFETY

Void.

##### 5.3 PROGRAMME AND METHOD STATEMENT

Void.

##### 5.4 METHODS AND PROCEDURES

###### 5.4.1 GENERAL

5.4.1.1 Before joining rails by field welding the horizontal and vertical alignment of the track for 5 m on either side of the joint shall be brought to within the final condition standard specified in the Project Specification, in terms of Specification E.10 Gen.

5.4.1.2 Prior to welding of rail joints, the role marks on the rails to be welded shall be identified, and the process determined in terms of specification SSS, or approved by the Engineer. Welding of joints, shall generally be by either the exothermic or by the flash butt welding process.

5.4.1.3 Welding of joints may be performed when the rail temperature is within range B as specified in Annexure H to specification E.10 Gen. provided that the rails are subsequently destressed.

5.4.1.4 The Contractor shall have two track thermometers in continuous use during welding. Rail temperatures shall be measured by placing the thermometer in the web of the rail 2 m from the rail ends, and shading it from direct sunlight. The thermometer shall remain in contact with the rail for at least ten minutes before it is read. Temperature readings shall be taken just prior to setting up of joint, and directly after stripping of joint.

5.4.1.5 The Contractor shall punch a number at each weld on the field side of the rail head to uniquely identify the weld, consisting of the day, month, year, letter "C" (for Contract), the welder's code number, and an approved consecutive number, or as is specified in the Project Specification.

5.4.1.6 The Contractor shall record the following information for each joint made by welding:

- i) The unique consecutive number, including the welder's code number.
- ii) The date of the weld.
- iii) The rail temperatures as specified in 5.4.1.4.
- iv) The location of the joint including -
  - a) The section of track;
  - b) Kilometre distance or the number of the nearest electrification mast; and,
  - c) Whether in the left or right hand rail in the direction of the increasing kilometrage.
- v) Rail mass
- vi) The portion number of thermit weld portions.
- vii) The times that the first and last sleeper fastenings on each rail were applied and/or tightened.

The Contractor shall sign and date the record and hand it to the Engineer on completion of the work for the day.

5.4.1.7 Where 36 m long rails are to be welded together in the track to form a long-welded rail panel, the following shall apply :

- i) Welding of joints in each leg shall proceed consecutively from the beginning of the panel to the end.
- ii) The sleeper fastenings of two rails being joined shall be loosened before welding so that the rail ahead is loose and free from all restraint.
- iii) On completion of the welding of a joint the sleeper fastenings of the rail behind the joint shall be fastened immediately.
- iv) The rails shall only be loosened when the rail temperature is within range A for running lines and range D for yard tracks as specified in Annexure H to specification E.10 Gen. and the welding shall be completed and the rails refastened to the sleepers while the rail temperature remains within those ranges.
- v) When work is resumed after an interruption during which the rail temperature went outside the abovementioned ranges, the rails behind the joint to be welded shall be loosened over a distance which incorporates at least 80 sleepers into the portion of the panel previously correctly welded up and fastened.

As an Alternative to the procedures specified in 5.4.1.7(i) to (v) hereof the Contractor may weld the joints at any rail temperature and afterwards destress the long welded rails in accordance with specification E.10/5 at his own cost.

5.4.1.8 The following conditions shall apply to welders using the exothermic welding process.

- a) The Engineer will test each person to be used as a welder by the Contractor.
- b) The Engineer will issue a certificate, valid for this contract only, for each person tested and found competent.
- c) The Contractor shall not permit any person who does not hold such a welding certificate to perform welding of rails.

5.4.1.9 Should any weld fail to comply with the standards specified, the Contractor shall, at his own cost, take such remedial action as required by the Engineer.

#### 5.4.2 EXOTHERMIC PROCESS

5.4.2.1 Exothermic welding of long welded rails shall be completed, up to the stage when the mould is removed, within rail temperature ranges A and D in Annexure H to specification E.10 Gen. if the rails were laid and fastened down within this range or if the rails were laid outside this range and subsequently distressed.

5.4.2.2 Exothermic welding shall be performed in accordance with Track Welding Specification SSS-5, 6 and 11.

#### 5.4.3 BUTT WELDING PROCESS

5.4.3.1 The Contractor shall only use a flush butt welding process that has been approved by the Engineer.

5.4.3.2 Where rails must be cut, it shall be done by railsaw or abrasive disc. Flame cutting will not be permitted. The joint shall be so positioned as to not be on top of a sleeper, and preferably halfway between sleepers.

5.4.3.3 The crown and underside over a minimum length of 360 mm and the face on each rail to be joined shall be derusted and descaled leaving no grooves, to allow good electrical contact between the jaws of the flash butt welding machine and the ends of the rails.

5.4.3.4 When setting up joints for flash butt welding, the Contractor shall ensure that the rail ends are in line using a one metre straight edge along the rail surface and the running sides of the crown.

After welding any remaining mismatch in the crown shall be ground to a taper of not more than 1:500 on the field side of the rails.

5.4.3.5 The joint shall not be chipped or hollow stripped, and chiselled gouge marks in the vicinity of the joint will not be permitted.

5.4.3.6 All flash butt welded joints welded outside the track shall be straightened in the horizontal and vertical planes to within the tolerances specified in clause 6.2.1 hereof.

- 5.4.3.7 The Contractor shall ensure that the rail temperature is within the applicable range specified in table 1 hereof prior to straightening the rails so that no distortion will take place on cooling after straightening :

TABLE 1

	RAIL TYPE	TEMPERATURE RANGE
	HCOB	200 °C to 350 °C
	UIC - A	400 °C to 550 °C
	UIC - B	400 °C to 550 °C
	UIC - C	400 °C to 550 °C
	CrMn	400 °C to 550 °C

- 5.4.3.8 The under and upper surfaces of the flange at a butt welded joint shall be ground smooth. The edges of the flange of a flash butt welded joint shall be rounded off so as to avoid damage to the elastic rail pads and to eliminate stress risers.
- 5.4.3.9 All welded joints shall be ground so that the running top is smooth and the crown is of the correct rail contour within the tolerances specified in clause 6.2 hereof.
- 5.4.3.10 When the sides of rails are welded out of alignment up to a maximum of 1,0 mm, the joint shall be ground at a taper of not more than 1:500 on both sides of the rails.
- 5.4.3.11 The Contractor shall cut out and reweld misaligned joints which he welded out of alignment in excess of 1,0 mm.

## 5.5 STANDARDS

Void.

## 5.6 COMPLETION

Void.

## 6. TOLERANCES

### 6.1 EXOTHERMIC PROCESS

The quality and dimensions of rail joints made by exothermic welding shall be within the limits specified in Track Welding Specification SSS-11.

### 6.2 BUTT WELDING PROCESS

- 6.2.1 All flash butt welded joints shall be examined for straightness by means of a 1,0 m straight edge placed on top and on the running edge of the crown and shall be straight to within the following tolerances:

- (i) On the running top of the rail, a 0,2 mm feeler gauge shall not enter at any point along a 1,0 m straight edge placed centrally over the joint.
- (ii) On the running edge of the rail, a 0,3 mm feeler gauge shall not enter at any point along a 1,0 m straight edge placed over the joint on the side of the rail crown.

6.2.2 The weld metal shall be well formed and free of oxidation, cracks, lack of fusion, inclusions, porosity and any foreign matter.

6.2.3 The heat affected zone (HAZ) shall not exceed 4 mm on either side of the joint.

## **7. TESTING**

### **7.1 EXOTHERMIC PROCESS**

7.1.1 The Contractor shall measure all rail joints made by exothermic welding to check that they are within the tolerances specified in Track Welding Specification SSS-11.

7.1.2 The Contractor shall carry out tests on welds done, and provide the Engineer with the test results, as specified in the Project Specification.

7.1.3 The Engineer will instruct the Contractor to carry out any additional tests he deems necessary.

### **7.2 BUTT WELDING PROCESS**

7.2.1 Bend, hardness, radiographic and ultrasonic tests will be performed throughout the duration of the contract to verify the quality of the butt welding process, as specified in 7.2.2, 7.2.3 and 7.2.4 hereof.

#### **7.2.2 Bend Tests**

7.2.2.1 Two 600 mm lengths of rail shall be flash-butt welded together to form a 1,2 m length by using the prevailing flash-butt welding procedure.

7.2.2.2 These test pieces will be required at the Engineer's discretion and shall be welded in the presence of the Engineer. An indication of number of welds to be allowed for in the tender price, will be given in the Project Specification.

7.2.2.3 The test pieces shall be handed to the Engineer who will arrange for the bend tests to be done.

7.2.2.4 The Contractor may elect to have a representative to witness the bend test.



- 7.2.2.5 When bent in the plane of its minor axis, the central deflection before fracture of a test piece shall not be less than specified in table 2 hereof.

TABLE 2

	RAIL PROFILE	IDENTITY ROLLING MARK	DEFLECTION
	30/40 kg	None for HCOB	40 mm
	48 kg	None for HCOB	40 mm
	48 kg	UIC Grade A	35 mm
	48 kg	UIC Grade B	30 mm
	57 kg	UIC Grade A	30 mm
	57 kg	UIC Grade B	25 mm
	60 kg	CrMn	20 mm

- 7.2.2.6 The fracture face shall be free of oxidised metal, craters, weld lenses, porosity or embrittled metal.

- 7.2.2.7 Each bend test shall be recorded and the record shall contain the following information:

by the Contractor :-

- i) Test numbers
- ii) Type of welding machine
- iii) Date of test
- iv) Movement of rail at pre-heat, flashing and upset (mm)
- v) Force at preheat, flashing and upset (kN)
- vi) Electric current at preheat, flashing and upset (kA)
- vii) Rail profile
- viii) Rail composition
- ix) Time taken from set up of the welding process until application of post-heat process.

by the Engineer :-

- x) Load at fracture (kN)
- xi) Deflection at fracture (mm)

- 7.2.2.8 Where the results of the bend test do not comply with the specifications :-
- i) A close inspection of the test piece which failed shall be undertaken to determine the cause of the failure.
  - ii) The welding machine shall be checked and reset where necessary,
  - iii) Further bend tests shall be undertaken until at least two sound welds are made in succession.
  - iv) The welding machine shall not be used for production work from the time of the test failure until two consecutive test pieces have proved successful.

7.2.3 Hardness curve on welds

7.2.3.1 The Contractor shall carry out, at the Engineer's discretion on which welds, hardness tests on the running surface of completed welds in accordance with the Vickers test as per specification BS 427. These tests shall be done before work hardening of the rail crown takes place, and the test results shall be presented in an acceptable format to the Engineer.

7.2.3.2 The hardness in the vicinity of the weld shall be within the limits given in table 3 hereof.

TABLE 3

	RAIL STEEL	FINE GRAIN ZONE	COARSE GRAIN ZONE
HC0B		NOT LESS THAN 200 HV30	NOT MORE THAN 330 HV30
UIC-A	GRADE	210 HV30	330 HV30
UIC-A	GRADE	230 HV30	350 HV30
CrMn	grade	270 HV30	430 HV30

7.2.3.3 The width of the fine grained zone having a hardness below that of the rail steel, shall not exceed 8 mm.

7.2.4 Radiographic and/or ultrasonic tests

7.2.4.1 The Contractor shall carry out tests on welds done, and provide the Engineer with the test results, as specified in the Project Specification.

7.2.4.2 The Engineer will instruct the Contractor to carry out any additional tests he deems necessary.

7.2.4.3 Welds that do not comply with the standards specified in clause 6.2 shall be cut out and be re-welded at the Contractor's cost.

**8. MEASUREMENT AND PAYMENT****8.1 SCHEDULED ITEMS****8.1.1 Exothermic welding of rail joints in track ..... Unit: Joint**

Each rail joint made by exothermic field welding will be counted.

**8.1.1.1 Separate items will be scheduled for the following:**

- a) Rail section (kg/m).
- b) Running lines.
- c) Tracks in station yards.
- d) CrMn or other type.

**8.1.1.2 The rates tendered shall include for the following:**

- a) Exothermic portions and moulds.
- b) Aligning and cutting of rails.
- c) Measuring the temperature.
- d) Recording times and temperatures.
- e) Installing the moulds and heating the rails.
- f) Welding the rails.
- g) Removing the moulds and grinding.
- h) Loosening and fastening of sleeper/rail fastenings.
- i) Opening ballast around the Fast fastenings and boxing in ballast after re-fitting these fastenings.
- j) Measuring the track in accordance with this specification.

**8.1.2 Flash butt welding of rail joints.....Unit : joint**

Each rail joint made by field flash butt welding will be counted.

**8.1.2.1 Separate items will be scheduled for the following:**

- a) On track welding of rails in the track.
- b) On track welding of rails outside the track.
- c) Welding from off-track stand of rails outside the track.
- d) Running lines.
- e) Tracks in station yards.
- f) CrMn or other type.

**8.1.2.2 The rates tendered shall include for the following:**

- a) Aligning and cutting of rails.
- b) Measuring the temperature.
- c) Recording times and temperatures.
- d) Welding the rails.
- e) Grinding of the joints.
- f) Straightening of the rails.

- g) Loosening and fastening of sleeper/rail fastenings.
- h) Opening ballast around the Fast fastenings and boxing in ballast after re-fitting these fastenings.
- i) Measuring the track in accordance with this specification.

**8.1.3 Welding of test pieces..... Unit : Joint**

Each successfully welded test piece will be counted.

**8.1.3.1 Separate items will be scheduled for the following:**

- a) Exothermic welds.
- b) Flash butt welds.

**8.1.3.2 The rates tendered shall include for the following:**

- a) Preparing for the welding.
- b) Welding the joint.
- c) Grinding the weld.

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