

Standard Category 1

S1162

Conductor rail – Performance, design and configuration

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1 Purpose

The purpose of this Standard is to define the overall performance and design criteria for the conductor rail system.

2 Scope

2.1 This Standard applies to the conductor rail system. It covers:

- a) the fundamental design criteria to be met in any new proposal involving the conductor rail system;
- b) requirements to avoid the possibility of 'gapping';
- c) requirements to avoid buckling;
- d) requirements to enable smooth shoe interface;
- e) criteria for support and bonding of the conductor rail system.

2.2 Where it is mandatory that any of the supporting information in Section 5 of this standard is to be applied, the appropriate requirement is set in Section 3.

3 Requirements

3.1 System design

The conductor rail system shall be designed and installed to ensure that:

- a) it provides for the power requirements of the scheduled train service at all times;
- b) the risks of service disruption, fire hazard and accidental contact with the conductor rail system by railway personnel or the public are minimised.

3.2 Materials

3.2.1 Materials used in the conductor rail system, listed below, shall comply with T0406 (see clause 3.5 regarding slipper runs):

- a) conductor rail (steel or composite);
- b) ramps;
- c) fishplates;
- d) anchors and anchor struts;
- e) insulators, caps, clips and coachscrews;
- f) shims, pads and packings;
- g) safety blocks, pads and coachscrews;
- h) negative pedestals;
- i) protection boarding.

3.2.2 Further requirements regarding the selection and use of these materials are given in the following clauses.

3.3 Conductor rail

3.3.1 Conductor rail material

- 3.3.1.1 Composite conductor rail may be used generally and should be used if steel does not provide sufficient conductivity. However, proposals to convert from steel to composite conductor rail shall be subject to approval by the LU Power Engineer.

Note: Guidance on the use of composite conductor rail may be found in Track Handbook 12, G3212.

- 3.3.1.2 Where composite conductor rail is not used, the following steel conductor rail shall be used:

- a) in tube, except as in (c) below – Section 65 (65kg/m) rectangular section complying with BS 7865;
- b) in sub-surface and open – Section 75 (75kg/m) flat bottom section complying with BS 7865;
- c) positive conductor rail on those parts of the Central line between Liverpool Street and White City where tunnel clearances preclude the use of standard Section 65 rail – 26kg/m angle section.

- 3.3.1.3 Upside-down BH conductor rail shall be installed only for the maintenance of existing depot and siding installations and only where the existing rail supports are in a serviceable condition.

3.3.2 Minimum conductor rail length

The minimum length of plain conductor rail between welded or plated joints shall where practicable be 4.5m. Where it is not practicable to achieve 4.5m the maximum practicable length shall be used, subject to there being no more than one plated joint between adjacent insulators.

3.3.3 Maximum conductor rail length

- 3.3.3.1 The overall length of conductor rail (including plated or welded joints) shall cater for likely thermal expansion, stability of the conductor rail system and the maintenance of consistent power supply along its length.

- 3.3.3.2 The absolute maximum length of steel conductor rail between electrical connections (including joints) shall be determined as follows:

- a) the actual length of the conductor rail either side of the anchor position, measured to the electrical connection, shall be converted to an “equivalent length”, according to its curvature and exposure to thermal effects, using the multipliers in Table 1:

Table 1: Multipliers for conversion of actual to equivalent conductor rail length

	Open sections and openings in tunnel sections	Heat-affected zones (i.e. within 40m of tunnel portals and openings)	Tunnel sections other than heat-affected zones
Radius exceeding 600m	1.00	0.75	0.50
Radius between 600m and 300m	2.00	1.50	1.00
Radius below 300m	4.00	3.00	2.00

- b) the equivalent length either side of the anchor position shall be equalised as far as practicable and shall not exceed 400m.

Note:

Clause 3.3.3.2 is based on the following assumptions:

Open and Sub-surface sections: that the electrical connections can accommodate movement of 156mm each way from a central position (which in turn is based on assumed rail temperature ranges of 68C in Open sections and 34C in Sub-surface sections);

Tube sections: that a rail temperature range of 15C will induce movement of 70mm each way from a central position.

If there is any doubt that the electrical connections can accommodate these movements the length of conductor rail should be reduced as necessary.

The temperature ranges shown include some heating effect from the current in the conductor rail.

3.3.3.3 The absolute maximum length of composite conductor rail (including joints) between electrical connections shall not exceed 300m, except that this limit may be increased to 900m in tunnel sections as long as the radius exceeds 200m. The anchor position should be placed as close as practicable to the mid-point of the length of the rail.

3.3.4 Conductor rail jointing

3.3.4.1 Conductor rail joints shall permit the uninterrupted passage of a current collector shoe and ensure the mechanical and electrical continuity of the rail.

3.3.4.2 Joints in steel conductor rail shall be made by welding. Welds between unworn or equally-worn rails, other than Section 75, shall have a suitable strengthening plate or angle welded on the underside of the rail foot.

3.3.4.3 Welds shall be finished by grinding to achieve a profile compliant with 1-164.

3.3.4.4 Composite conductor rail shall be joined using fishplates.

3.3.5 Conductor rail ramps

3.3.5.1 All conductor rail ends that come into shoe contact shall be fitted with an approved design of ramp. The ramp shall permit the collector shoes to run onto and off the

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end of each length of conductor rail without damage to ramp, shoe gear or train motors and without creating a derailment or fire hazard. Account shall be taken of train speeds and influence of dynamic movement under load. As far as reasonably practicable, ramps shall be of the “high-speed” type but where for reasons of space or gapping risk this is not practicable, “low-speed” ramps may be used.

Note: In order to comply with clause 3.7 the clearance between ramp tips and tunnel lining ribs should be verified as adequate, or appropriate measures taken to provide the necessary insulation, when installing new ramps.

- 3.3.5.2 Conductor rail ramp material shall be compatible with that of the adjoining conductor rail.
- 3.3.5.3 Special positive conductor rail ramps, compatible with the conductor rail described in clause 3.3.1.2(c), shall be used as required in the tube section between Liverpool Street and White City.
- 3.3.5.4 Ramp design in junctionwork shall consider as a minimum the following factors:
 - a) gapping considerations;
 - b) type of turnout;
 - c) curvature;
 - d) speed;
 - e) direction of running.
- 3.3.5.5 Positive side pick-up ramps are permitted where continuity of the positive conductor rail is required to avoid unnecessary gapping. This type of ramp shall be avoided wherever possible. If used, they shall be carefully positioned to avoid fouling train-borne trip cocks.
- 3.3.5.6 In junctionwork the minimum distance between adjacent positive conductor rail ramps on different rails shall be 150mm for electrical separation. However, in exceptional circumstances and where authorised by the LU Head of Track Engineering or his authorised representative this separation distance may be reduced to not less than 75mm. The separation distance shall allow for possible thermal or other movement of the rails.

3.3.6 Gaps

- 3.3.6.1 Conductor rail gaps, overlaps and electrical continuity shall satisfy the power, rolling stock and operational requirements of the system.
- 3.3.6.2 In order that the power supply to trains is not interrupted, any required gaps shall be located to ensure, as far as is reasonably practicable, that:
 - a) interruptions in the power supply to the individual motor cars in the train are of sufficient duration to ensure that the traction control equipment stabilises before the supply of power is resumed (see also clause 3.3.6.3);
 - b) the risk of all the motor cars in the train losing shoe contact simultaneously is avoided;