Electric Traction Systems

In this section you will find guidance on tramway electric traction systems.

Trams should usually be supplied with electric traction power from overhead line systems at a voltage consistent with BS EN 50163 (BS EN 50162: Railway applications. Supply voltages of traction systems) **here.**

Exposed live conductor rails or similar systems should not be used on on-street sections. Use of alternative traction supply systems should be compliant with the Electricity at Work Regulations 1989 SI 1989/635 The Stationery Office 1989 ISBN 0 11 096635 X **here** and subject to risk assessment.

The physical design of overhead electric traction power supply systems for tramways should be compatible with the requirements and capabilities of the equipment of the trams to be operated on this system. The application of railway design criteria should be avoided as it is not appropriate for tramways, for example, trams can safely operate on higher wire gradients.

The guidance in this chapter is in line with the above and UK guidance, standards and regulations.

Overhead Line Equipment (OHLE)

Structures supporting an overhead electric traction power supply system should be positioned so that they neither significantly obstruct or endanger users of the highway, nor are unduly exposed to damage from an errant road vehicle or tram.

Electric traction poles with cantilever arms, or a system of span wires between traction poles or building attachments, may be used to support the OHLE.

The use of building attachments can assist where there are insufficient clearances within the highway (including access / maintenance to structures / frontages), to reduce street clutter to assist visibility for all road users, or if the location is particularly sensitive. In order to do this, sufficient Powers (for example through a TWA Order) would have to be in place, and the building to which the OHLE is being attached would have to undergo sufficient surveying and testing to confirm the tension can be supported.

For general clearance requirements to electric traction poles refer to the section on Tramway Clearances section **here** and also **here**.

Where footways are a minimum width (normally 1800 mm, as defined by the local Highway Authority) the Highway Authority may require the poles to be located beyond the back of the footway.

All electric traction poles should be resistant to climbing.

If tension weights are used in public places, they should be provided with an arrestment device in the event of a broken wire. In public areas, tension weight assemblies should either be shrouded or within the support column.

Structures supporting the OHLE and not bonded to the traction return (See IEC 60913 Railway applications – Fixed installations – Electric traction overhead contact lines **here** and BS EN 50122 Railway applications. Fixed installations. Electrical safety, earthing and the return circuit Protective provisions against electric shock **here**) should be at least double-insulated from live components. The primary insulation should be as close as possible to the live conductors.

The risk of insulation degradation leading to hazardous potential differences may be reduced to an acceptable level by the use of multiple insulators or lengths of continuous insulation in the contact wire support system of the OHLE.

Security of Overhead Line in the Event of Collapse or Loss of Any One Support

The design of the overhead line supports should aim to minimise the vulnerability of each support to damage. The loss of any one support, for example as a result of a fire loosening a building fixing or of a pole being struck and damaged by a road vehicle, may release tension in the overhead line system but the design should be sufficient to allow other supports to prevent live equipment from sagging below 5800 mm above the highway, see the Electrical Clearances section below. When off-street it may sag lower, provided that it remains out of reach of pedestrians.

Connections between the pole and the contact wire should be mechanically weaker than the contact wire system itself to ensure that if a pole is damaged, the connection will break before the live equipment is dragged down.

Use of Electric Traction Power Supply Poles for Street Lighting or Other Electrical Equipment

Where electric traction poles are used to support the street lighting system or other electrical equipment, precautions should be taken so that even under fault conditions, one power system cannot adversely affect the other.

Such precautions may include, for example, double insulation in respect of the different electrical systems or specially designed earthing systems.

Street lighting or other electrical equipment should be designed and installed so that it can be maintained safely without affecting the normal operating condition of the tramway system.

Management and Safe Operation of Power Supply

The design of the electric traction power supply system should be compliant with BS EN 50122 Parts 1, 2 and 3 **here**. This should include lightning and surge protection.

Isolating switches should be provided to give effective and efficient means of control of the power supply system under normal operating conditions as well as emergency situations. Such switches should be protected from casual interference by unauthorised people and located so as not to cause a hazard.

It is preferable for isolators to be located in secure trackside cabinets in positions protected from errant highway vehicles. Should it be necessary to mount isolators on traction supply columns, consideration should be given to protecting people from accessible live parts and ensuring a safe means of manual operation.

Factors such as the proximity of buildings / structures and the need for access for such matters as window cleaning need to be considered and may dictate the location of isolators.

Suitable protection arrangements should be provided so that whether in an emergency or as part of a planned isolation, normally live equipment can be bonded to the traction return system. Such arrangements should be capable of use without exposing staff to risks from road or tram traffic, and should not be able to be interfered with by road traffic or the public.

The electric traction supply feeding system should be capable of discriminating between fault currents and normal system load currents. The protection equipment should be able to detect all credible faults, for example, a short circuit at the remote end of a section being fed from the traction substation.

High-speed DC feeder circuit breakers should be provided that are capable of automatically disconnecting all power feeds to a short circuit in the traction system. Automatic re-close should not normally be used.

Sectioning

The electric traction system conductors should be sectioned electrically, and provision should be made to enable the electric traction supply to be disconnected. Where necessary, means should be provided to permit the equipment to be bonded to the traction return or otherwise made safe.

Care should be taken to locate section insulators in positions that do not create operational constraints, for example, immediately after leaving a tramstop, leaving tight curves, or within highway junctions etc.

Central Control Facilities

The tramway operational control room should have provision for the safe and efficient management of the electric traction power supply system. Where the traffic control is located separately from the electric traction power supply control, communication facilities should be provided between the two See the Control of Movement section **here**.

There should be a monitoring system that clearly shows the actual position or status of all monitored switches, isolators, circuit breakers or other devices controlling the power supply. This system should have provision to record all status indications, alarms and operator actions.

Arrangements for control of the traction supply should be such that under all conditions of the control system (normal, emergency or failure), a need for the emergency discharge of that supply at a particular location can be met within the response time required by the emergency services.

Sufficient information should be permanently displayed, or otherwise immediately available for display in the electric traction supply control facility, to enable the person in control to:
relate, with sufficient accuracy, the electrical distribution system to the geography of the tramway;
and make safe the area affected by an incident in terms of tramway operation and electrical supply.

Avoidance of Dangerous Touch Potentials to Adjacent Structures

Where it is possible to touch equipment at the return and earth potentials simultaneously, this hazard should be assessed to ensure that dangerous touch potentials are mitigated in other ways. For guidance, refer to BS EN 50122-1 **here**.

Unbonded structures and other conductive equipment alongside the tramway will normally be at the local Earth potential of the locality. The rails and body of a tram may be at a different potential from local Earth, particularly at sites remote from feeder stations and under fault current conditions.

Where equipment has to be connected to a different earthing system, precautions should be taken to prevent danger to people who could touch both systems simultaneously.

Use of Running Rail as Return Conductors

Where the running rails are used for the return of electric traction current the along-track resistance should be designed and maintained to be ALARP, and the rails should be nominally insulated from local Earth and not deliberately earthed at any point. However, the rails within the confines of maintenance depots should be earthed.

See also guidance in LRG 15.0 Stray Current Management Guidance **here**.

Minimisation of Leakage of Stray Current to Local Earth

The design of the electric traction supply system should ensure that leakage of stray current is minimised. The distance between electrical sub-station feeds is important and shorter distances along with minimising the return resistance by the use of adequate rail section or additional return conductors will reduce the rail to earth potential that drives stray current. In addition, the levels of stray current may be reduced during a substation outage where there are increased feeding distances.

Long term leakage of direct current may give rise to the risk of galvanic corrosion of structures and apparatus in the vicinity of the tramway.

Direct currents in the local Earth may lead to dangerous malfunction of tramway equipment (such as interference with track circuits) as well as to other third party equipment in the vicinity.

At depots, in order to avoid excessive leakage current, the traction supply may require a separate traction substation that is normally not connected to the main tramway traction feeding system.

Refer to LRG 15.0 Stray Current Management Guidance **here** for further guidance on the management of stray currents.

In relation to Electromagnetic Compatibility (EMC), guidance is available in **LRG 3.0** Management of Electromagnetic Compatibility **here.**

Electrical Clearances

The appropriate clearances for tramway systems are defined in BS EN 50119 Railway applications (BS EN 50119 Railway applications. Fixed installations. Electric traction overhead contact lines) **here** and BS EN 50121-1 (BS EN 50121-1 Railway applications. Electromagnetic compatibility. General information **here**)

Height

The height of the contact wire or any other live part of the overhead electric traction supply system must not be less than 5800 mm above the surface of any carriageway at the maximum temperature of the wire. See Electricity Supply Regulations 1988 **here**.

Any proposal to use a lower position (for example, because of an existing bridge) would require express statutory authority or an exemption from the Secretary of State for Transport.

At places accessible to the public, the position of the contact wire or any other uninsulated live part of the overhead electric traction supply system must be not less than 5200 mm above the ground or from a surface on which a person might reasonably stand, at the maximum temperature of the wire.

Snow and ice loading may reduce the height of the contact wire or other live parts so need to be considered in the above wire positions.

Where the headroom below the contact wire is reduced, the safe height should be indicated on road traffic signs as seen in diagram 779 in the **Traffic Signs Regulations and General Directions** (TSRGD) **here** both in advance and also at the location of the reduction.

The indicated safe height for voltages up to 750 V DC should be at least 460 mm less than the actual headroom unless height gauges are installed. If height gauges are installed, the indicated safe height should be at least 380 mm less than the actual headroom.

Arrangements for Overhead Electric Traction Power Supply Systems on DfT High Load Routes

Where a DfT high load route intersects a tramway and a diversion of the high load route is not possible, special arrangements should be provided, for example, a means of lifting the OHLE for the passage of a high load.