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**SUPERSEDED**

## 3 ELECTRIC TRACTION SYSTEMS

### 3.1. SAFE FOR PEOPLE

#### Principle 3.1 Safe for people

*An electric traction system should minimise safety hazards to people.*

#### 3.1.1. Electric Traction System

3.1.1.1. In considering the protection of people from safety hazards due to the electric traction system the application of conductor rail systems is not preferred by the RSC due to the greater associated risks.

#### 3.1.2. Protection against unwanted access

The following measures should be undertaken to prevent unwanted access to the electric traction system.

#### 3.1.3. Fencing

3.1.3.1. All electrified railways should be suitably protected against inadvertent access and trespass. Where necessary, additional or special fencing should be provided, eg near to public places such as schools, recreation grounds etc.

*Note: Guidance for boundary fencing is given in section 1 Permanent Way, Earthworks and Structures.*

#### 3.1.4. On bridges and other structures

3.1.4.1. Bridges that cross over an electrified railway with overhead line equipment should have measures designed to prevent inadvertent access and deter climbing access to the live equipment. Parapets and stairwells should be provided. The wall (parapet) should be solid or Class 2 SX (as defined in EN 50511) 1.8m high. Where the clearance to the equipment is at least 1.2m then the lower 0.8m section of the parapet should be constructed with minimum 1200mm<sup>2</sup> mesh. The parapet shall be designed to prevent access for standing or walking and deter climbing. Further guidance may be obtained in EN 50122-1.

*Note EN 50122-1:1997 Railway Applications Fixed Installations Part 1. Protective provisions relating to electrical safety and earthing.*

3.1.4.2. Uninsulated overhead line equipment should not be located closer than 3000mm to the outer end of any bridge parapet.

3.1.4.3. At cuttings, wing walls, retaining walls or on other structures which make the live equipment more readily accessible, further measures may be necessary.

*Note: Guidance for bridges and other structures is given in section 1 Permanent Way, Earthworks and Structures.*

#### 3.1.5. At level crossings with overhead line systems

3.1.5.1. At public road level crossings, the clearance between the crossing surface and the lowest portion of the overhead line equipment should not be less than 5600mm to provide a safe clearance for road vehicles.

3.1.5.2. Where the RSC has approved an overhead line equipment height below 5600mm, a height gauge to indicate the maximum safe height should be provided on each side of the crossing. In calculating the safe height, due regard should be paid to the effect of the vertical profile of the crossing on vehicles using it, including trailers, loads and equipment.

3.1.5.3. At non-public level crossings, the clearance between the crossing surface and the lowest portion of the overhead line equipment should be agreed between the railway and the occupier and is subject to agreement by the RSC. Height gauges should be provided if there is a risk of vehicles or their loads coming into close proximity to overhead line equipment.

**3.1.6. Warning signs and notices**

- 3.1.6.1. Places where passengers on foot have normal access at stations should not require sign posting.
- 3.1.6.2. At all other authorised places of direct public or workers access to electrified lines or electrical equipment locations and enclosures, signs giving suitable warning of the dangers from live electrical equipment should be displayed.
- 3.1.6.3. Particular attention should be given to sign posting at level crossings, platform ramps and work areas.
- 3.1.6.4. Any access ladders or points of access to roofs and other places where people could approach live equipment in the course of their duties should carry warning signs.
- 3.1.6.5. Consideration should be given to providing warning signs:
- where the railway is adjacent to public places such as schools or recreation areas;
  - at premises where cranes, or other equipment, are used and there is a risk of encroachment onto the overhead line equipment. Other safeguards may also be necessary;
  - where bare traction feeders are used.
- 3.1.6.6. Where applicable signs should be in accordance with the Safety, Health and Welfare at Work (Signs) Regulations, 1995 and the Traffic Signs Manual section 6.11, or as formally agreed with the RSC. Additional warning signs and notices may be provided. However, these shall not contradict the forgoing requirements.
- 3.1.6.7. Appropriate warning signs should also be provided on trains, mobile plant and road vehicles used on the railway.

**3.1.7. Equipment positioning**

- 3.1.7.1. All electric traction conductors on overhead systems and all live equipment associated with the operation of an electrified railway must be positioned or protected so as to minimise danger to people. Reference should also be made to statutory instrument SI (1993) Safety, Health and Welfare at Work (General Applications) Regulations, 1993 Part VIII Electricity and EN 50122-1.

*Note EN 50122-1:1997 Railway Applications Fixed Installations Part 1. Protective provisions relating to electrical safety and earthing.*

- 3.1.7.2. Except where agreed with the RSC, public and private utility electrified and conductive communication lines must not pass over the electric traction conductors for overhead systems, except where they are integrated within a rigid structure or otherwise prevented from falling on the electric traction conductors.
- 3.1.7.3. Bare electric traction system feeder wires should be kept to a minimum. On electrified lines where they run parallel to or across the track they should be prominently signed unless otherwise agreed by the RSC. Where bare electric traction system feeders are provided adjacent to non-electrified tracks, or such feeders have to cross non-electrified tracks the clearances specified in section 1 Permanent Way, Earthworks and Structures should apply.
- 3.1.7.4. Supporting structures for overhead line electric traction system conductors should be located within the boundary of the infrastructure controller's premises. If this not the case then the infrastructure controller should ensure that the earthing and bonding requirements are still fulfilled and inadvertent connection between the railway earthing system and other system is prevented.
- 3.1.7.5. Bare live equipment associated with overhead line traction systems should be kept to a minimum and should be sited to minimise danger. Live equipment should not extend over non-electrified lines, over the platforms or any other public part of a station. In cases of special difficulty, up to half the length of the earthed end of an insulator may extend over such places. The running rails of non-electrified lines should be segregated by insulated rail joints.
- 3.1.7.6. In goods yards and depots, live equipment should not normally be provided over working or loading areas. Where this cannot be avoided, increased wire height and other precautions may

be necessary.

3.1.7.7. Return conductors should always be insulated with respect to earth. Return conductors should be insulated in areas of public or workers access where they are within arm's reach of the standing point.

3.1.7.8. Working or access platforms, walkways etc over live overhead equipment should have standing surfaces, toe boards, screens/guard-rails etc that afford suitable protection for people against the risk of electric shock from foreseeable activities at the location.

### 3.1.8. Anti-climbing protection

3.1.8.1. Overhead equipment structures and supports should be of a design, which cannot easily be climbed. Where this is not achieved and either there is public access to the structure or trespass is likely, anti-climbing protection should be provided.

3.1.8.2. Access to fixed ladders should be denied in areas prone to trespass.

3.1.8.3. The means of access to any roof or other place, which could allow people to approach live equipment, should be secured or otherwise protected.

3.1.8.4. Structures outside or above railway property should be protected to minimise trespass or access to overhead line equipment.

### 3.1.9. Safety screening

3.1.9.1. Suitable safety clearances should be achieved by positioning the overhead equipment at an appropriate distance greater than arm's reach from any accessible place. Further guidance on clearance distance may be found in the European Norm EN 50122-1:1997. Where this cannot be achieved, a screen or other suitable obstacle should be interposed between the accessible place and the live equipment. Solid screens are preferred but if a mesh screen is used the maximum mesh size should not exceed 125 mm.

### 10. Earthing and bonding

10.1. The overriding requirement is to prevent harm from electric shock by ensuring that under normal and foreseeable fault conditions the touch and step potential between conductive structures does not exceed the safe recommended maximum and that protective devices operate effectively. Installations shall comply with the requirements Statutory Instrument 44 (1993) Safety, Health and Welfare at Work (General Applications) Regulations, 1993 Part VIII Electricity. Further guidance may also be found in the European Norm EN 50122-1:1997. All exposed conductive structures, which could become energised under fault conditions should be earthed and if necessary cross-bonded. The need to bond exposed conductive structures to the appropriate electric traction return should be considered. In this case they shall not be connected to earth. For conductive structures of small dimensions, which do not support or contain electrical equipment it is not necessary to take any protective measures. Such structures include for example signposts, drain covers, etc.

*Note EN 50122-1:1997 Railway Applications Fixed Installations Part 1. Protective provisions relating to electrical safety and earthing.*

### 3.1.11. Fire

3.1.11.1. The fire load, flammability and potential smoke and fume generation of electric traction cables and equipment in areas where people are likely to be present should be minimised. Additional measures may be required for tunnel and sub surface areas.

### 3.1.12. Other considerations

3.1.12.1. Where airfields are situated adjacent to an electrified railway, special protection may be necessary to minimise the risks posed to either system in the event of an aircraft emergency.

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**3.2. COMPATIBILITY****Principle 3.2 Compatibility**

*Electric traction systems should not generate or be at risk from dangerous interactions with any other systems.*

**3.2.1. Precautions against electrolytic damage and electromagnetic interference**

3.2.1.1. Details of the strategy to be taken against electrolytic damage and electromagnetic interference should be advised to the RSC for agreement at the planning stage. Guidance may also be obtained in EN 50122-2 and EN50121 Parts 1-5.

*Note 1 EN 50122-2:1999 Railway Applications Fixed Installations Part 2. Protective provisions against the effects of stray currents caused by d.c. traction systems.*

*Note 2 EN50121 Parts 1 to 5 Railway Applications: Electromagnetic Compatibility.*

**3.2.2. Traction Return Current**

3.2.2.1. The path of traction return current should be adequately controlled to prevent excessive touch potentials, electrolytic corrosion and electromagnetic interference. Further guidance may be obtained in EN 50122-2.

*Note 1 Traction return current will be conducted by structures other than those intended, due to leakage resistance, intentional and unintentional bonding. This can give rise to touch potentials between adjacent structures.*

*Note 2 Maintaining a consistent level of the traction and supply system will help to reduce leakage currents.*

*Note 3 Minimising the resistance of the return path will help to reduce leakage currents.*

*Note 4 EN 50122-2:1999 Railway Applications Fixed Installations Part 2. Protective provisions against the effects of stray currents caused by d.c. traction systems.*

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**3.2.3. Electromagnetic Interference**

3.2.3.1. An assessment should be made of the electromagnetic compatibility between the electric traction system, rolling stock and the signalling systems. It should demonstrate that the proposed installation will neither cause nor be subject to an increase in risk due to electromagnetic interference.

**3.2.4. Electrical clearances - Overhead systems**

3.2.4.1. The design of the overhead line electrical equipment should include provision for the following:

- (a) the safe electrical clearance between the earthed material of any structure and the live parts of the overhead line equipment and pantograph taking account of dynamic effects;
- (b) the safe electrical clearance between the live parts of the overhead line equipment and the kinematic envelope taking into account the effects of horizontal and vertical curvature;
- (c) the tolerances in the installation and maintenance of the overhead line equipment; and
- (d) the tolerances in installation and maintenance of the alignment, height, and cross-level of the track.

3.2.4.2. The clearances required are divided into two categories:

- (a) Static clearance - defined as the safe distance between the earthed material of any structure and the live parts of the overhead line equipment, under any permissible tolerance conditions.
- (b) Passing clearance - defined as the safe distance between the earthed material of any structure or rail vehicle and the live parts of the overhead line equipment, or between any earthed material and the pantograph under any permissible conditions of operation and maintenance. It

takes into account dynamic effects including the uplift from a pantograph.

3.2.4.3. Values for the static and passing clearances are:

	Up to and including 750V dc		Up to and including 1500V dc		Up to and including 25kV ac	
	Normal Minimum	Special Reduced	Normal Minimum	Special Reduced	Normal Minimum	Special Reduced
STATIC CLEARANCE	75mm	Note 1	150mm	100mm	200mm	150mm
PASSING CLEARANCE	25mm	Note 1	100mm	80mm	150mm	125mm Note 2
<p>Notes</p> <p>1) For voltages up to 750 V dc nominal minimum clearance result more from physical phenomena than electrical clearance so that smaller clearances are general impractical.</p> <p>2) The passing clearance between a pantograph and a brick or masonry bridge or tunnel, may be reduced to 80mm, with the prior agreement of the RSC.</p>						

Table 1: Static and passing clearances

3.2.4.4. On existing railways:

(a) normal clearances should be achieved wherever reasonably practicable;

special reduced clearances may be used in cases of extreme difficulty should be used with the prior approval of the RSC.

exceptionally, special engineering solutions may be used in cases of extreme difficulty and with the prior approval of the RSC.

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3.2.4.5. For new railways, better than normal clearances should be provided.

3.2.4.6. At structures crossing the line where the overhead line equipment is not attached to them or supported immediately adjacent to them, not less than normal clearances should be provided.

3.2.4.7. Additional measures may be necessary to maintain special reduced clearances under all conditions. These clearances should not be eroded by tolerances in any circumstances. Datum marks to indicate the position of the track should be provided at any structures adjacent to places where the overhead line equipment is installed, using the special reduced clearances or where other reduced infrastructure clearances have been permitted.

**3.3. CONTROL****Principle 3.3 Control**

*Appropriate facilities should be provided to safely manage and control electric traction systems in normal and all foreseeable degraded and emergency conditions.*

- 3.3.1.1. Where different electric traction systems come into close proximity with one another, consideration should be given to the need to provide protection against foreseeable effects from one system to the other that might give rise to danger.

**3.3.2. Control and sectioning**

- 3.3.2.1. 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 earthed or otherwise made safe.

- 3.3.2.2. On underground railway systems means should be provided throughout the tunnels and on station platforms for the disconnection of traction current. This may be on request to the control room by radio or tunnel telephone system. The same system of discharging the current should be used throughout the tunnels of the underground railway.

- 3.3.2.3. The electric traction system together with its feeder arrangements should be supervised from one or more railway electrical control rooms where means should be provided to disconnect the electric traction power from any part of the system. The railway electrical control room should also be provided with a means of disconnecting the supply to incoming feeders to the electric traction system.

- 3.3.2.4. There should be efficient communications between the lineside and the railway electrical control room to enable changes in the state of the electric traction system to be properly undertaken and controlled.

- 3.3.2.5. The electric traction system arrangements should be located in the same room from which the operation of the railway is controlled. Where this is not available, a prioritised secure and direct communications link is required between the two centres. A backup alternative should be available to cater for failure of the primary communications link.

- 3.3.2.6. Where there is an interface between electrified and non-electrified lines, a branch line for example, a sufficient 'buffer zone' should be provided on the non-electrified line to allow for traction return currents to flow. Equipment installed in the 'buffer zone' should also be compatible with electric traction.

- 3.3.2.7. The track of any non-electrified siding, particularly if it serves private premises, should be insulated from any electrified line to avoid dangers arising from electric traction currents. Special precautions should be taken if flammable goods are handled and suitable warning notices should be provided.

- 3.3.2.8. Electrical equipment and structures should carry a unique means of identification.

**3.3.3. Earthing and bonding**

- 3.3.3.1. Bridges that cross over a railway electrified with overhead line equipment should have measures designed to prevent danger from touch potentials. Where there is exposed metalwork no earth connections are allowed, however the need to bond to the appropriate electric traction return should be considered.

- 3.3.3.2. Consideration should be given to bonding metal structures adjacent to the line to the electric traction return unless other measures are taken to avoid dangerous touch potentials arising. Where equipment has to be connected to a different earthing system, precautions should be taken to prevent danger arising from people touching both systems simultaneously.

- 3.3.3.3. Leakage and circulating currents should be minimised and the methods used should be demonstrable. Further guidance is provided in EN 50122-2:1999 for dc railways.

*Note 1 EN 50122-2:1999 Railway Applications Fixed Installations Part 2. Protective provisions against the effects of stray currents caused by d.c. traction systems.*

- 3.3.3.4. Appropriate measures should be taken on dc systems to avoid dangerous touch potentials.
- 3.3.3.5. Where a railway electrical sub-station or switching station is adjacent to an electricity authority supply station and a common earthing system cannot be provided, each of the installations, including any fencing and gates surrounding it, may require its own earthing system. The distance between the sub-station and supply station, or the fencing shall be sufficient to prevent people from simultaneously touching any exposed metalwork connected to such independent earthing systems.
- 3.3.3.6. Consideration should be given to the effect of the movement of any gates or other means of access to electrical switching or sub-stations to ensure clearances are not eroded during their operation.
- 3.3.3.7. Where the running rails are used as an electric traction current return conductor, the arrangement and frequency of rail and inter-track bonds shall be such that people cannot be subject to an electric shock likely to cause them harm. Bonds that have been disconnected should be suitably placed and safeguarded to prevent danger to people and damage to other equipment.
- 3.3.4. Fault protection**
- 3.3.4.1. A direct short-circuit in the electric traction system shall cause the power supply to be automatically disconnected. Equipment that differentiates between fault current characteristics and normal loads is preferred.
- 3.3.5. Precautions against contamination of insulators**
- 3.3.5.1. In areas of anticipated high contamination of electric traction insulators from industrial pollution or from saline drips and sprays (eg in tunnels, near to the coast, road traffic on adjacent roads etc) special consideration should be given to their protection. This may be by screening, cleaning or other means to ensure the safety and reliability of the supply. Creepage distances over insulators should be designed to minimize the effects of contamination.

**SUPERSEDED**