LIGHT RAIL
Safety and Standards Board

Tramway Principles and Guidance (TPG)

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TITLE:	**TRAMWAY PRINCIPLES AND GUIDANCE (TPG)**				
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DESCRIPTION:

THIS DOCUMENT PROVIDES TRAMWAY PRINCIPLES AND GUIDANCE.

EXPLANATORY NOTE:

The Light Rail Safety Standards Board is not a regulatory body and compliance with Guidance Notes or Approved Codes of Practice is not mandatory; they reflect good practice and are advisory only. Through their Memorandum of Understanding, LRSSB and ORR have a shared interest in standards, guidance and advice to support compliance with the legal framework for health and safety on tramways and light rail systems. Both organisations agree to actively cooperate in the development and review of material by offering the option to the other to provide comment during drafting and review. Users are recommended to evaluate the guidance against their own arrangements in a structured and systematic way, noting that parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not adopt) elements of the guidance should be documented. Compliance with any or all the contents herein is entirely at an organisation's own discretion.

SOURCE / RELATED DOCUMENTS:

The following LRSSB documents referenced in this document are correct at time of publication. For a full library of current documents refer to the LRSSB website [https://resources.lrssb.org/].

LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users (LRSSB)
LRG 3.0 Management of Electromagnetic Compatibility (EMC) Guidance (LRSSB)
LRG 4.0 Signing and Marking of Tramways Guidance (LRSSB)
LRG 5.0 Tramway Audible Warning Acoustic Test Guidance (LRSSB)
LRG 6.0 Fatigue Management Guidance (LRSSB)
LRG 8.0 Guidance in the Management of Vulnerable Persons (LRSSB)
LRG 9.0 Driver Selection and Recruitment Guidance (LRSSB)
LRG 11.0 Medical Fitness Guidance (LRSSB)
LRG 12.0 Guidance for the Statutory Reporting of Incidents (RIDDOR) (LRSSB)
LRG 15.0 Stray Current Management Guidance (LRSSB)
LRG 16.0 Wheel Rail Interface Guidance (LRSSB)
LRG 17.0 Driver Inattention Systems Guidance (LRSSB)
LRG 18.0 Speed Management Systems Guidance (LRSSB)
LRG 19.0 Cycle Tramway Interface Guidance (LRSSB)
LRG 20.0 Fire and Rescue Guidance (LRSSB)
LRG 21.0 OLE Maintenance and Reference Manual (LRSSB)
LRG 22.0 Guidance on the Management of Embedded and Grooved Rail Breaks (LRSSB)
LRG 23.0 Application of the Construction (Design and Management) Regulations 2015 (LRSSB)
LRG 24.0 Pedestrian Safety Guidance (LRSSB)
LRG 27.0 Confidential Reporting Guidance (LRSSB)
LRG 28.0 Guidance on the Provision of Accessibility in Light Rail Systems (LRSSB)
LRG 29.0 Guidance for Human Factors in Operation Control Centres (LRSSB)

LRG 30.0 Depot Control Centre (LRSSB)
LRG 31.0 Network Supervision Management Guidance (LRSSB)
LRG 32.0 Testing and Commissioning Guidance (LRSSB)
LRG 33.0 Guidance on the Management of Drugs and Alcohol (LRSSB)
LRG 34.0 Guidance on Control of Contracted Works (LRSSB)
LRG 37.0 Weather and Climate Resilience (LRSSB)
LRG 38.0 Noise and Vibration Guidance (LRSSB)
LRG 40.0 Overhead Line Systems Training and Competency Guidance (LRSSB)
LRG 41.0 Road Safety Audit (RSA) Guidance (LRSSB)
See also Appendix H: References

RELATED TRAINING COURSES:	RELATED LEGISLATION:
N/A	Health and Safety at Work Act etc. 1974 Management of Health and Safety at Work Regulations 1999 Railways and Other Guided Transport Systems (Safety) Regulations (ROGS) 2006 (as amended) See also Appendix H: References

CHANGE NOTES:

Date of Issue	Issue No.	Revision No.	Reviewer	Details of Revision
09/05/2019	01	01	D Keay	Amendments to text / format
15/07/2019	01	02	D Keay	Amendments to text / format
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TRAMWAY PRINCIPLES AND GUIDANCE (TPG)

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Figures

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Revisions From Previous Issue:

New LRG document template and other formatting.

Changes to Page 1 including the removal of the named preparer, reviewer and authorising person and insertion of an explanatory note in relation to the status of this document.

Additional LRG document references inserted into the front table on Page 1 and 2 to reflect documents published since the last revision of LRG 1.0., as also referenced throughout this document.

Changes to Tables A and B in relation to existing and new text (in Section 10).

Changes to the Introduction to be consistent with other LRG documentation.

Removal of text in Section 4 related to cycle / tramway interface. This is replaced by reference to LRG 19.0 Cycle Tramway Interface Guidance.

Text inserted relating to Road Safety Audits.

New Section 10 inserted to provide high level guidance and to reference documents in relation to operational issues that have been published by LRSSB since the previous issue.

Tables in Appendix D amended to reflect examples of UK tramway LRT signals and end point indicators.

Additional and / or undated references to documents, regulations and legislation etc from existing and new text resulting renumbering of some references, changes to Appendix H and throughout document.

Numerous minor presentational, factual and typographical changes.

Links to documents updated due to replacement documents or internet locations.

Text added where required / appropriate including to aid clarification.

TERMS AND ABBREVIATIONS

Table A – Terms

Term	Definition
Degraded Conditions	Where any component or part of the tramway materially affecting safety has failed and the tramway is not operating in its normal operating condition.
Driver Assistance Systems	An amalgam of technologies that assist drivers in driving tasks.
Driver Vigilance Device	A dynamic system that monitors tasks being performed by the driver whilst the vehicle is in motion. Lack of detected activity results in an alert. If further activity is not detected following an alert, then an intervention is triggered.
Duty Holder	Person in charge of operational activities at a particular time
Dynamic Envelope	The tram static envelope enlarged to allow for the maximum possible displacement of the tram in motion with respect to the rails on straight track.
Emergency Situations	An unexpected disruption of normal operation that presents immediate risks.
Failed Tram	A tram that is failed and incapacitated on the network and is unable to function.
Fault Condition	Status of tram vehicle when it is not fully operational or is impaired due to a fault.
Hazard Brake	Emergency 3 application.
Highway Traffic	Any highway vehicle and / or pedestrian on the highway / pavement including cyclists and those riding scooters.
Highway Users	Any highway vehicle and / or pedestrian on the highway / pavement including cyclists and those riding scooters.
Infrastructure Manager	Person who is responsible for developing and maintaining that infrastructure or manages and uses that infrastructure / station, or permits it to be used for the operation of a vehicle (defined by ROGS).
Integrated On-Street Tramway	Where the part of the highway occupied by the rails may also be used by other highway users or by pedestrians.
Kinematic Envelope	The dynamic envelope enlarged to allow for the permitted tolerances in track gauge, alignment, level and cross-level and the dynamic and static effects of track wear.
Lifeguard (Obstacle Deflector)	A fixed guard providing underrun protection in front of the leading wheels designed to prevent people or objects being run over by the tram. This is in addition to any wheel guard provided in front of the wheels for the purpose of obstacle deflection. It may have a deflecting lower edge of pliable material to close the gap to any paved surface or track infill designed for the purpose of underrun protection.

Term	Definition
Line of Sight	Operating mode where a tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation using the service brake.
Normal Operating Conditions	Operation of a tramway or highway as designed.
Off-Street Tramway	Where the alignment of the track is wholly separate from the highway.
Passive Sign	A warning or information sign using pictograms and / or numbers.
Responsible Person	A person or body responsible for safety in the absence of an operator for a system.
Road Traffic Light Signal Controller	An electronic system controlling all signals in a highway within a defined area.
Security Brake	A braking application higher than Emergency 3 (Hazard Brake).
Segregated On-Street Tramways (Tram-Only Street)	Where the part of the highway occupied by rails may be crossed by pedestrians, but is not normally shared with other highway users.
Service Braking	Normal mode of braking operation.
Swept Envelope	The speed dependent kinematic envelope that is unique to the particular location at a given speed.
Tram Gates	Where only trams (and buses if permitted) travel along a short length of highway that precedes an integrated on-street system.
Tram Static Envelope	The maximum cross-sectional dimensions of trams to be used on the tramway and, where applicable, their loads when at rest on straight and level track.
Tramway Crossing Hazard Zone	The area of a crossing that extends between 600 mm from the SE of the tram on one side to 600 mm from the SE on the other side of the crossing.
Tramway Path	The area reserved for a moving tram in its environment. (It is derived from the SE by adding the minimum appropriate clearance.)
Transport and Works Act (TWA) Order (or Transport and Works (Scotland) (TAWS) Act Order)	Statutory process for attaining Powers to build operate and maintain a tramway or Light Rail system.
Wheel Guard	A frangible device positioned in front of the leading wheel set that is designed to prevent objects being over-run or caught between the wheels.

Table B – Abbreviations

Abbreviation	Definition
AC	Alternating Current
ALARP	As Low as Reasonably Practicable
AVSMS	Automatic Vehicle Speed Management Systems
BS EN	British (BS) adoption of a European (EN) Standard
DAS	Driver Assistance Systems
DC	Direct Current
DfT	Department for Transport
DSD	Driver Safety Device
DVD	Driver Vigilance Device
EEC	European Economic Community
EU	European Union
HMRI	Her Majesty's Railway Inspectorate
HSE	Health and Safety Executive
HSWA	Health and Safety at Work etc Act 1974
HF	Human Factors
IEC	International Electrotechnical Commission
km/h	Kilometres Per Hour
LED	Light Emitting Diode
LRSSB	Light Rail Safety and Standards Board
LRT	Light Rapid Transit
m	Metres
mm	Millimetre
NRSWA	New Roads and Street Works Act 1991
OCC	Operations Control Centre
OFCOM	Office of Communications
OLE	Overhead Line Equipment
ORR	Office of Rail and Road
PCV	Passenger Carrying Vehicle
RAIB	Rail Accident Investigation Branch
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013

Abbreviation	Definition
ROGS	Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended)
RSA	Road Safety Audit
RTA	Road Traffic Act 1988
RTRA	Road Traffic Regulation Act 1984
RVAR	Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010
SE	Swept Envelope
SMS	Safety Management System
SoS	Secretary of State for Transport
SPAS	Signal Passed at Stop
TAWS	Transport and Works (Scotland)
TBC	Traction Brake Controller
TOPAS	Traffic Open Products and Specifications
TPG	Tramway Principles and Guidance
TROs	Traffic Regulation Orders
TRTS	Tram Ready to Start
TSM	Traffic Signs Manual
TSRGD	Traffic Signs Regulations and General Directions 2016
TWA	Transport and Works Act
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
UTC	Urban Traffic Control
V	Voltage
V&V	Safety Verification and Validation
VCA	Vehicle Certification Agency
VLDs	Voltage Limiting Devices
WTR	Working Time Regulations (as amended) 1998

1. Introduction

1.1 This document is published by the Light Rail Safety and Standards Board (LRSSB) for the design, construction, operation and maintenance of tramways (Light Rail Systems) in the United Kingdom (UK).

1.2 Throughout this document, reference is made to other supplementary LRSSB (LRG) documents where considered appropriate to provide clarification and additional detail. For access to the current and up to date documents comprising of sector standards, guidance, good practice and technical notes readers are directed to the LRSSB reference library available on the LRSSB website[1].

1.3 This document is not prescriptive and is intended to give advice and not set an absolute or mandatory standard and it is based upon goal setting principles as good practice.

1.4 This publication indicates what specific aspects of tramways (or similar Light Rail systems) need to be considered, especially their integration within existing highways. This document does not intend to set out mandatory standards, instead, it gives examples of established good practice to provide an acceptable level of safety for the public (passengers and others), employees and contractors.

1.5 Much of this document is based on the experience gained from existing UK tramway systems and published documents. It does not prescribe particular arrangements adopted by any of these systems and is intended to give guidance and advice.

1.6 This document is not intended to be applied retrospectively to existing tramway systems except where this can be achieved where reasonably practicable, for example, operational procedures. However, new or altered works, plant and equipment might introduce incompatibilities or inconsistencies with the existing works, plant or equipment. Therefore in these circumstances and in the guise of continual improvement, owners and operators should consider and assess any implementation of this document and / or any subsequent revision to maintain an 'as low as reasonably practicable' (ALARP) condition with appropriate arrangements made to address any safety implications, which may include modifications to the existing works, plant or equipment.

1.7 It is hoped that promoters of tramways, their design and construction teams and operators of tramways will find this document helpful, and that it will also be of help to others such as town planners and highway engineers, whose contribution to the development of a tramway system is essential.

1.8 This document replaces guidance previously published by the Office of Rail and Road (ORR), and before that by Her Majesty's Railway Inspectorate (HMRI) building on the long-standing legislation and guidance of the Board of Trade.

1.9 This document has been developed with the assistance of the ORR, and ORR inspectors may look to see that it has been suitably applied when assessing the safety of tramways.

1 LRSSB: https://resources.lrssb.org/

1.10 This and other LRSSB Light Rail Guidance (LRG) documents that are referred to in this document will be regularly updated to reflect standards produced by the LRSSB. All information and links to documents that are contained within this document are correct at time of publication.

2. Scope

2.1. This document is for those involved in the design, construction, operation and maintenance of tramways. For some topics, further and / or more detailed LRSSB documents are available separately as accompanying documents (as referred to on Pages 1 and 2 and throughout this document).

2.2. This document also refers to relevant regulations, standards and guidance. Where this is not available, reference is made to good practice within the UK.

2.3. When constructing or extending tramway systems or its subsystems, it may be appropriate to consider innovative solutions to particular problems. As such, this document is not intended to inhibit innovation, technological improvements or restrict solutions to new problems.

2.4. When referring to the design, construction and operation of on-street tramways, this also extends to tramways in the following circumstances:

- Aspects of off-street tramways where sections of track intersect with the highway, or change to or from on-street tramways; and
- Off-street tramways, which are governed by the requirements of other parts of the tramway system that are on-street.

Application of this Document

2.5. Application of this document should generally provide a sufficient level of safety, provided that it has been demonstrated that the use of this document is wholly applicable to the works, plant or equipment in question. The term ‘equipment’ is used here and elsewhere in the text to include vehicles.

Operating Conditions

2.6. The choice and design of any works, plant and equipment will depend not only on the information provided in this document, but also on the operational requirements of the tramway, including any interfaces with other systems as well as the environment in which the tramway operates.

2.7. In assessing the suitability of any proposed safety measures or arrangements on a tramway, it is important to consider the following (not exclusively):

- The tramway’s normal operating conditions;
- Degraded conditions where any component or part of the tramway materially affecting safety has failed;
- Credible abnormal conditions to which the system may be subjected; and
- Emergency situations.

Designing and Building

2.8. In addition to this document, designers and constructers need to be aware of the responsibilities imposed upon them by the Construction (Design and Management) Regulations 2015 (as amended)[2] (CDM). This document has been produced in line with the CDM Regulations.

2.9. The CDM Regulations cover any new or altered works, plant and equipment for tramways. Their design and construction should consider not only the safety of the users of the system but also that of other highway users and those in the vicinity of the tramway. For further information, refer to LRG 23.0 Application of the Construction (Design and Management) Regulations 2015.

2.10. Any additions or alterations to a tramway should never degrade the level of safety of the original system.

2.11. The design of a tramway should be managed according to good practice in safety management coherently as one system, from the initial concept and development then following throughout the lifecycle of the scheme. Tramway design and related urban redevelopment should be integrated with respect to managing vehicle and pedestrian safety.

2.12. The design of a tramway in terms of the consideration and management of safety has a number of stages as described below.

Initial Stages of Responsibility For Safety

2.13. Responsibility for safety starts at the planning and development stage of a new or revised tramway, from the beginning of the design process and is transferred via documentation such as a hazard log throughout all the stages of the scheme.

2.14. It should be fully understood that in the normal process of developing proposals for a new tramway, there are many issues that need to be identified and resolved before a construction contract is let or an application is submitted for a Transport and Works Act (TWA) Order[3] for England and Wales, or Transport and Works (Scotland) Act (TAWS) Order[4] for Scotland.

2.15. When an application is made for a TWA or TAWS Order, or when a construction contract is let, there should be no outstanding safety issues relating to an outline design that remain unconsidered or unresolved. I.e., they are identified, controlled (prevented or mitigated) eliminated, managed or mitigated etc.

2.16. Resolution of outstanding safety issues through new or altered design may, for example, not be achievable within the legal framework of the TWA or TAWS Order once the application has been submitted or the Order is made, as there may be insufficient land and / or Powers. Once the boundaries have been set by a TWA or TAWS Order they cannot be increased, and the design of the tramway has to work within those limits (of land and Powers etc).

2 Construction (Design and Management) Regulations 2015: https://www.legislation.gov.uk/uksi/2015/51/introduction

3 Transport and Works Act 1992: http://www.legislation.gov.uk/ukpga/1992/42/contents

4 Transport and Works (Scotland) Act 2007 (asp.8): https://www.legislation.gov.uk/asp/2007/8/contents

2.17. It is essential that any contractual relationships within the scheme facilitate clear ownership and management of a continuous safety management process. As part of this, the safety management and associated records of design information and assumptions should be capable of being transferred to the relevant Responsible Person as the contractual process develops. A Responsible Person should be appointed at each stage of the project lifecycle.

2.18. The Responsible Person is a term defined in The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended) (ROGS)[5] to define a person or body responsible for safety in the absence of an operator for a system. This is most likely to occur in new tramways where there is no operator in place and a new system is being designed and constructed.

Contributory Factors In Safety

2.19. Factors that may affect safety are addressed in the following sections of this document. However, some of these issues may not be applicable in all situations, i.e. they are not necessarily exclusive, and specific scheme factors need to be taken into consideration.

2.20. Evidence of all considerations should be included in the records under a Safety Management System (SMS). Normally these records would be included or referred to in the Hazard Log generated within the SMS, and should include any residual hazards identified as part of the design process in accordance with the CDM Regulations. Refer to LRG 23.0 Application of the Construction (Design and Management) Regulations 2015 for further information.

Safety Management System (SMS)

2.21. The SMS shall be compliant with ROGS[6] and further guidance is given by the ORR[7]. An SMS should be implemented which identifies, controls (prevents or mitigates) and records potential hazards and clearly demonstrates that all risks have been controlled to a level as low as reasonably practicable ALARP. It is essential that safety is managed adequately across the interfaces of different organisations and at all stages in the development, design, operation and maintenance of a scheme / tramway.

Recognition of All Stages In A Design Process

2.22. In progressing a design there needs to be recognition of the actions required to proceed to the next level of closing out an identified hazard. A Hazard Log shall be produced and populated throughout the process. This should be implemented to identify, control (prevents or mitigates) and record potential hazards and clearly demonstrates that all risks have been controlled to a level ALARP.

5 The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended): https://www.legislation.gov.uk/uksi/2006/599/contents

6 ROGS Regulation 6: https://www.legislation.gov.uk/uksi/2006/599/regulation/6

7 Strategy for regulation of health and safety risks - chapter 1: Health & Safety Management Systems: https://www.orr.gov.uk/sites/default/files/om/safety-strategy-chapter-1.pdf#:~:text=An%20SMS%20is%20more%20than%20a%20written%20policy,managed%20to%20deliver%20effective%20and%20efficient%20risk%20control.

2.23. It should not be assumed that a hazard can be closed without an understanding of what is required to achieve this and what can realistically be achieved. Alternative means should always be considered and recorded in the interests of minimising the risk in failing to close out a hazard.

Passage of Hazards Down the Supply Chain

2.24. When passing the mitigation of hazards down the supply chain or along the lifecycle of a scheme, care should be taken to ensure that all parties involved in the issues are fully aware of the hazard and its identifications and other mitigating actions given to other parties.

2.25. Mitigations should not be passed down to single parties without a clear mutual understanding of the singularity and ownership of such particular issues. When passing down hazard mitigation to more than one party, a management process is required in order to optimise the combined hazard mitigation.

2.26. It is recommended that a 'Project Safety Certification Committee' be established to oversee hazard closeout in accordance with SMS good practice.

2.27. Ultimately it is the responsibility of the operator to accept all hazards have been sufficiently closed out prior to commencing operations.

2.28. Refer to LRG 34.0 Guidance on Control of Contracted Works for further information.

Recognition of All System Interrelationships

2.29. Many of the system design factors are interrelated. This needs to be recognised and managed in an integrated manner during all stages of the design or modification of a tramway.

2.30. Interfaces should be identified and managed from an early stage in the scheme using defined procedures within a project management system.

Safety Verification

2.31. ROGS came into force in 2006. These Regulations removed the requirement for new and modified works to receive approval from the HMRI before being brought into use.

2.32. Duty holders are required to have in place an overarching SMS that includes processes for controlling risks from new and modified works. In some cases where works are a type new to the system in question and also which are capable of creating significant risks, a specific process termed safety verification shall be applied.

2.33. In some cases, the specific enabling legislation for a tram system (for example, a TWA or TAWS Order), may contain provisions that require approval for certain aspects of the tramway to be obtained before being brought into operation.

Definition of Tramway

2.34. For the purposes of this document, the use of the term 'tramway' aligns with the definition provided in EN 17343:2023[8] where a tram system is defined as:

"urban rail system operated on separate infrastructure or infrastructure shared with road traffic, or both

Note 1 to entry: The tram system comprises the tram network, related rolling stock, and the associated operation.

Note 2 to entry: Sections of the route can be signal controlled.

Note 3 to entry: A tram network can be linked to other rail networks.

Note 4 to entry: For tram systems having sections segregated from road traffic the term light rail system (LRS) may be used.

Note 5 to entry: Road traffic includes road users like cars, pedestrians, cyclists, wheelchair users, etc."

2.35. Although there is no legal definition for 'Light Rail', in this document, the term 'Light Rail system' means tramway.

2.36. Different parts of a tramway may fall into one of the following several broad types:

- 'Integrated on-street' tramways where the part of the highway occupied by the rails may also be used by other highway vehicles or by pedestrians;
- 'Tram gates', where only trams (and buses if permitted) travel along a short length of highway that precedes an integrated on-street system;
- 'Segregated on-street' tramways or 'tram-only streets' where the part of the highway occupied by rails may be crossed by pedestrians, but is not normally shared with other highway users; or
- 'Off-street' tramways where the alignment of the track is wholly separate from the highway, sometimes referred to as 'tramroad'.

2.37. Focus on historic and replica tramways is given in Appendix B. A 'heritage tramway' is defined in the Health and Safety (Enforcing Authorities for Railways and Other Guided Transport Systems) Regulations 2006[9] as meaning.

"a tramway which is operated to

(a) preserve, re-create or simulate tramways of the past; or

(b) demonstrate or operate historical or special types of motive power or rolling stock;

and is exclusively or primarily used for tourist, educational or recreational purposes".

8 EN 17343:2023 Railway Application - General Terms and Definitions

9 The Health and Safety (Enforcing Authorities for Railways and Other Guided Transport Systems) Regulations 2006: https://www.legislation.gov.uk/uksi/2006/557

Operation by Line of Sight

2.38. Tramways use line of sight operation. In this mode of operation, a tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation by using the service brake.

Tramways and Highway / Road Traffic Law

2.39. On-street tramway vehicles are 'tramcars' for the purposes of road traffic legislation[10]. In some instances, they are included in the definition of motor vehicles.

2.40. The Tramcars and Trolley Vehicles (Modification of Enactments) Regulations 1992[11] (The Modification Regulations) specify the sections of the Road Traffic Regulation Act 1984 (RTRA)[12] and the Road Traffic Act 1988 (RTA)[13] which do not apply to trams, or apply with modifications.

2.41. Trams are not subject to the Road Vehicles (Construction and Use) Regulations 1986[14] including those parts that refer to passenger carrying vehicles (PCVs), nor to any of the lighting requirements, unless these are applied to these regulations by any Act or Order authorising the construction of the tramway or by any other specific statutory instrument.

2.42. Refer to Appendix F and Appendix H for further information and references to applicable legislation and regulations. This document does not make reference to all regulations and standards, but highlights those that are the most specific to tramways.

Street Works Protection Arrangements

2.43. General requirements for the carrying out of street works and reinstatement are imposed by the New Roads and Street Works Act 1991 (NRSWA)[15] For England and Wales, and the New Roads and Street Works Act 1991 (Commencement No 1) (Scotland) Order 1991 for Scotland[16]. The methods of protecting some types of work sites on the street are described in a Code of Practice issued under that Act, the Safety at Street Works and Road Works[17] and in the Traffic Signs Manual (TSM)[18].

10 As defined in the Public Passenger Vehicles Act 1981: https://www.legislation.gov.uk/ukpga/1981/14
11 Tramcars and Trolley Vehicles (Modification of Enactments) Regulations 1992: http://www.legislation.gov.uk/uksi/1992/1217/contents/made
12 Road Traffic Regulation Act 1984: http://www.legislation.gov.uk/ukpga/1984/27/contents
13 Road Traffic Act 1988: http://www.legislation.gov.uk/ukpga/1988/52/contents
14 The Road Vehicles (Construction and Use) Regulations 1986: https://www.legislation.gov.uk/uksi/1986/1078/contents
15 New Roads and Street Works Act 1991: http://www.legislation.gov.uk/ukpga/1991/22/contents
16 New Roads and Street Works Act 1991 (Commencement No 1) (Scotland) Order 1991: https://www.legislation.gov.uk/uksi/1991/2286/contents/made#:~:text=This%20Order%20brings%20into%20force%E2%80%94on%2021st%20October%201991%2C,and%20Schedules%208%20and%209%20to%2C%20the%20Act.
17 Safety at Street Works and Road Works: A Code of Practice: https://www.gov.uk/government/publications/safety-at-street-works-and-road-works
18 The Traffic Signs Manual: https://www.gov.uk/government/publications/traffic-signs-manual

Other Regulations and Standards

2.44. Works, plant or equipment may be subject to other specific regulations, for example, the Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010[19] (RVAR) and The Electricity Safety, Quality and Continuity Regulations 2002[20].

2.45. In implementing this document, compliance with all other relevant regulations shall be considered. Although specific reference is made to the more significant regulations in this document, references are not made to all available regulations and standards.

2.46. Any material or article used in the provision of works, plant or equipment may also need to comply with a specific standard. This document does not refer to these numerous standards. However, an indication is provided where standards may be appropriate.

2.47. Any reference in this document to any material or article complying with a specific UK or European Union (EU) standard applied in another country would normally be satisfied by compliance with a standard from that country which delivers an equivalent level of safety, suitability and fitness for purpose to the standard referred to in this document. It remains the responsibility of the infrastructure designer and then the duty holder during operation to assure themselves of the equivalence of any alternative standard.

2.48. Tramway works are subject to legislation pertaining to noise and vibration through the design and also the life of the tramway. For further information, refer to LRG 38.0 Noise and Vibration Guidance.

2.49. Trams on highway are subject to relevant road and traffic signage legislation. Where a deviation or derogation from the Traffic Signs Regulations and General Directions 2016 (TSRGD)[21] is required, then this shall be obtained from the Secretary of State for Transport (SoS) (or their agents). Refer to LRG 4.0 Signing and Marking of Tramways Guidance for further information.

2.50. Refer to Appendix F and Appendix H for further information on regulations and standards.

Terminology

2.51. For the purposes of this document, the verbs listed below are used with the following specific meanings:

- Should – a recommendation, to be met on a 'comply or explain' basis;
- May – where the guidance suggests options;
- Shall – only used where there is a legal requirement for the measures described to be employed and a reference to the relevant Act or regulations is provided; and
- Is (are) required – having decided upon a particular option or arrangement, some consequential choices stem from that first decision. This expression is used to indicate those consequential choices and where firmer guidance is considered appropriate.

19 The Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010: https://www.legislation.gov.uk/uksi/2010/432/contents

20 Electricity Safety, Quality and Continuity Regulations 2002: https://www.legislation.gov.uk/uksi/2002/2665/contents

21 Traffic Signs Regulations and General Directions 2016: http://www.legislation.gov.uk/uksi/2016/362/contents

Trams

2.52. In this document, tramcars and any other vehicles that operate on tramways are referred to hereafter as 'trams'. This includes one or more trams coupled together and includes vehicles that are rail mounted maintenance vehicles.

Highway

2.53. In this document, 'highway', 'street' or 'road' is used to mean any, or any combination of, the following:

- Carriageway;
- Bridleway;
- Cycle track;
- Footpath;
- Footway;
- Land on the verge of a carriageway referred to as 'side reservation' or between two carriageways referred to as 'central reservation'; and
- Any other place to which the public has access (including access only on making a payment).

2.54. The terms used here are more precisely defined in the Highways Act 1980[22] for England and Wales or for Scotland, in the Roads (Scotland) Act 1984[23].

2.55. The term 'traffic lane' used in this document has the same meaning as in TSRGD, as below:

> *"a part of the carriageway intended for use by vehicles travelling in a particular direction or reserved for use by vehicles of a particular type and separated from other parts of the carriageway by road markings".*

2.56. A traffic lane may be limited to a particular transport mode for example tram lane, bus lane or cycle lane. In this document, the term 'Highway Authority' should be taken to include Roads Authority or Local Traffic Authority.

22 Highways Act 1980: http://www.legislation.gov.uk/ukpga/1980/66/contents
23 Roads (Scotland) Act 1984: http://www.legislation.gov.uk/ukpga/1984/54/contents

3. Tramway Clearances

3.1. This Section provides information on the clearances within the tramway system, and also between the tramway and other parts of the highway and is in line with good practice. For information on electrical clearances refer to Section 7 of this document. In addition, clearance diagrams for a variety of situations are given in Appendix G.

3.2. Adequate lateral clearances should be provided to allow trams to pass one another on adjacent tracks, or between trams and other highway vehicles on adjacent carriageways, as well as between trams and fixed structures, to allow for the presence of people.

3.3. These clearances should be developed from the Swept Envelope (SE) as defined below and should consider any additional allowances for pedestrians, cyclists and other highway vehicles. Refer to LRG 19.0 Cycle Tramway Interface Guidance and LRG 24.0 Pedestrian Safety Guidance for further information.

3.4. Where a system uses a variety of trams, the effects of different kinematic envelopes needs to be considered.

3.5. In terms of clearances where a high-sided vehicle is on a cambered highway adjacent to a tramway, the clearance between the top of the vehicle and the higher parts of a tram could be less than the clearance at ground level.

3.6. Where tramways cross Local Authority boundaries to include more than one local Highway Authority, the tramway system should seek consistency across its network regardless of the different Highway Authority preferences.

Definition of Tramway Path

3.7. The tramway path (the area reserved for a moving tram in its environment) is derived from the SE by adding the minimum appropriate clearance.

3.8. The definition of the SE is based upon the kinematic envelope as defined below.

3.9. Previously, UK tramways have used the term Developed Kinematic Envelope (DKE), rather than SE. Although the terms are mutually interchangeable and represent the same practical effects, use of the term SE will help to give better consistency with European practice. Therefore, it is recommended that the term SE is used in place of DKE.

<u>Tram Static Envelope</u>

3.10. The tram static envelope is that formed by the maximum cross-sectional dimensions of trams to be used on the tramway and where applicable, their loads when at rest on straight and level track.

3.11. The tram static envelope should take into account allowances for tolerances in the manufacture of the trams and the effects on the suspension of tram loading and loads arising from the wind and other weather.

3.12. It should not include driving mirrors where these are designed to deflect as with other highway vehicles. However, clearances to fixed highway obstructions will still need to be considered.

Dynamic Envelope

3.13. The dynamic envelope is the tram static envelope enlarged to allow for the maximum possible displacement of the tram in motion with respect to the rails on straight track.

3.14. The dynamic envelope should consider tram suspension characteristics and allowances for tolerances in the maintenance of trams, including wear.

3.15. The effects of end-throw and centre-throw of trams on curved track are not included, and are disregarded in the development of the dynamic envelope.

Kinematic Envelope

3.16. The kinematic envelope is the dynamic envelope enlarged to allow for the permitted tolerances in track gauge, alignment, level and cross-level and the dynamic and static effects of track wear.

3.17. The kinematic envelope is speed dependent.

3.18. The kinematic envelope is developed to take into account all the possible effects of curvature, including super elevation of the track, and end and centre throw of the tram.

Swept Envelope (SE)

3.19. The SE is speed dependent like the kinematic envelope, but is unique to the particular location at a given speed.

3.20. Over-generous methods of calculation of the SE should be avoided, as they may mislead other highway users as to which parts of the highway are safely accessible to them. They may also create unnecessary design constraints.

3.21. The effects of high centre of gravity in low-floor trams and of independently rotating wheel sets may also need to be considered.

3.22. The enlarged SE of a tram in a credible degraded condition (such as suspension failure) should not exceed the normal SE plus the clearance to any fixed object or the established SE of a tram on an adjacent track. This should allow a tram to be recovered, albeit at reduced speed, without it coming into contact with structures or other passing trams.

Clearances Between Trams

3.23. The clearances between the SEs of two adjacent trams should be not less than the following:

- 100 mm without centre traction poles; and
- 600 mm with traction poles between the two SEs (but at least 100 mm from the face of the nearest side of a pole to each SE).

3.24. The above clearances are minimum clearances up to 2100 mm above ground level. At heights above 2100 mm, reduced clearances may be acceptable and should be agreed with the Infrastructure Owner and the Operator.

Clearances Between Trams and Structures

3.25. The clearances between an SE and other highway features or fixed structures should be as follows:

- 100 mm to an isolated obstruction in the centre of the carriageway or on a side reservation;
- 200 mm to the edge of a traffic lane;
- 300 mm to a kerb (where pedestrians are excluded); and
- 600 mm to a continuous obstruction in the centre of the carriageway or on a side reservation, for example walls or lengths of guard railing etc.

3.26. The above clearances are minimum clearances up to 2100 mm above ground level. However, where circumstances permit, appropriate greater clearances should be adopted. At heights above 2100 mm, reduced clearances may be acceptable and should be agreed with the Infrastructure Owner, Operator and Highway Authority.

3.27. The above clearance distances should take into account pedestrian movements in the provision of adequate clearances between the SE and any structure or pole.

Clearances on Highways

3.28. Traffic lanes used by trams and other large vehicles, such as buses, coaches and heavy goods vehicles etc. should normally be 3650 mm wide for a two-lane carriageway.

3.29. Lane widths that are shared between trams and other highway vehicles will probably be dictated by the needs of the latter.

3.30. A minimum lane width should be 3250 mm unless agreed with the relevant Highway Authority.

3.31. The overall layout within constricted urban areas may benefit from a detailed assessment of lane widths actually required depending on the classes of traffic that are to use each lane, for example buses only, but taxis may be allowed to use bus lanes.

3.32. The Road Vehicles (Construction and Use) (Amendment) (No.6) Regulations 1995[24] permit vehicles up to 2550 mm wide on a highway, and mirrors can be outside of this measurement so the effective overall width of such a vehicle can be as much as 3000 mm. This may need to be considered where there are traffic lanes adjacent to those used by trams.

3.33. The widths of the lanes used by trams are based on a tram having an overall width of 2650 mm. Where narrower trams are used, the recommended lane widths for sole use by trams may be reduced and where wider trams are used, the recommended lane widths might need to be increased.

24 Road Vehicle (Construction and Use) (Amendment) (No.6) Regulations 1995: http://www.legislation.gov.uk/uksi/1995/3051/contents/made

4. Integrating the Tramway with the Highway

4.1. This Section provides information on the general design, layout for integration of the tramway with the highway and is in line with the TSRGD and TSM. Refer to LRG 4.0 Signing and Marking of Tramways Guidance and LRG 24.0 Pedestrian Safety Guidance for further information.

4.2. Where the tramway is located in a highway and sharing traffic lanes with other highway users, its design and construction should allow it to be used safely by those other highway users.

4.3. Where the tramway runs along the highway, crosses it, or is otherwise close to it, provisions to promote compatibility between trams and other highway users should be incorporated into the tramway highway design.

4.4. The arrangements for normal operating conditions and for emergency situations should be clearly defined for the type of infrastructure over which trams are operating. These should include any appropriate audible / visible warnings as well as evacuation and control procedures in case of emergencies. Provisions shall be made during any highway or tramway maintenance operations for the safe movement of pedestrians and other highway users in compliance with NRSWA.

4.5. In areas of integrated on-street tramways, trams may run in a traffic lane with other highway vehicles and so they will be subject to Traffic Regulation Orders (TROs). In areas of segregated on-street tramways where trams may run in a space immediately adjacent to traffic lanes in either side reservation or in central reservation, TROs may also be required.

4.6. In areas where trams are segregated from other traffic lanes in central or side reservations, normal highway signage and lineage is not necessarily used, as these are tram only areas.

4.7. It is important to use prescribed signs and where necessary use TROs to ensure that enforcement is possible to deter other highway users from entering tram only areas.

4.8. Further information on signage is provided in LRG 4.0 Signing and Marking of Tramways Guidance.

4.9. It is important that appropriate measures capable of enforcement are taken to prevent other highway vehicles entering areas of a tramway that is segregated from other traffic lanes. This may be done, for example, by using bollards between tracks, the provision of tram gates or the use of coloured cats eyes, road markings, no entry signs, rumble strips etc.

4.10. TROs may be used to exclude most highway vehicles and cycles, apart from those which are permitted, for example, for access to frontages or for highway sweepers etc.

4.11. Particular attention should be paid to the design of highway junctions and locations where the form of tramway alignment changes, for example, from side to central reservation, or from integrated to segregated on-street tramway.

4.12. The operation of tramways shall be consistent with rules set out in the Highway Code[25] when operating on the highway.

25 The Highway Code: https://www.gov.uk/guidance/the-highway-code

Alignment Considerations

4.13. The alignment of the tramway should take into consideration the following (not exclusively):

- The highway layout, for example intersections, roundabouts etc;
- Pedestrian footways and crossings (refer to LRG 24.0 Pedestrian Safety Guidance);
- Cyclists and cycle lanes (refer to LRG 19.0 Cycle Tramway Interface Guidance);
- The needs of frontages for access and property maintenance (this may include those not immediately on the highway but whose main / only access may be affected);
- Public utilities, and access requirements if it is identified that these cannot be undertaken with the tramway in (normal) operation;
- Tramway clearances (refer to Section 3 and Appendix G);
- The permitted minimum radii of horizontal and vertical curvature, the combinations thereof and the other engineering constraints for the tramway and its trams;
- The location and design of tramstops (refer to Section 6);
- The location of overhead electric traction equipment and other fixed structures (refer to Section 7 and LRG 21.0 OLE Maintenance and Reference Manual); and
- Drainage.

Highway Intersections

4.14. In the design and operation of an on-street tramway, it is particularly important to recognise that the behaviour of other highway users (including pedestrians and other non-motorised users) will influence the safety of the tramway. Therefore the design and operation may need to consider likely deliberate actions and errors of judgement by other highway users. A risk assessment may indicate that signage and / or markings are an appropriate control measure at some locations. The degree of signing or signalling may require permitted enhancements in accordance with the TSM.

Tramway Intersections with Other Highways

4.15. At-grade intersections of tramways with other highways are highway traffic junctions, and shall not get confused with the definition of a railway level crossing (in the Level Crossings Act 1983[26]).

4.16. The arrangements for controlling the tramway and other highway traffic at an intersection should be co-ordinated. At intersections with minor highways, the tramway should be regarded as if it were the major highway even if the relative volume of traffic suggests otherwise.

4.17. The design of junctions should take account of good practice and recommendations on visibility splays in highway design guidance. Information can be found in documents such as the Design Manual for Roads and Bridges[27] (DMRB), or the Department for Transport (DfT) Manual for Streets[28].

26 The Level Crossings Act 1983: https://www.legislation.gov.uk/ukpga/1983/16/contents
27 Design Manual for Roads and Bridges: https://www.standardsforhighways.co.uk/dmrb
28 Manual for Streets, Department for Transport 2007: https://www.gov.uk/government/publications/manual-for-streets

4.18. The maximum permitted approach speed of trams to intersections may have to be limited so they can negotiate the junction safely. The approach speed to an intersection should enable a tram to stop safely if the intersection is obstructed. The place from which the intersection first comes clearly into view and then remains in view for the tram driver should be identified, so that the available braking distance can be established. The permitted maximum speed should be based on this distance and normal service braking rates.

4.19. Where a tram is being integrated into an existing highway and the maximum prescribed indivisibility splay cannot be achieved, speeds lower than the highway design speed may be required.

4.20. The visibility splay for a tram driver should be calculated from the driver's fixed seat position to a set-back measured from the SE, and not from the kerb line. Refer to Figure 6.1 in LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users and BS EN 16186-5:2021+A1:2023[29].

4.21. It is helpful if the view of the intersection includes the *Stop* or *Give Way* highway lines and yellow box junctions on the other approaches. This aids the tram driver in their judgement as to the likely movements of other vehicles.

4.22. Where a segregated on-street tramway runs immediately alongside a carriageway or in a central reservation between carriageways and it intersects another highway, the intersection should be signalled or signed.

4.23. At each highway intersection there should be an assessment of the risks to highway traffic turning across the tramway. This should aim to highlight issues such as, for example, overhead line equipment (OLE) poles adjacent to crossings that could trap a highway vehicle in the event of a collision with a tram or to identify the potential for signage to be mounted on poles with frangible bases.

4.24. Where a segregated on-street section of tramway runs parallel to one side of a highway but some distance from it, and a side highway crosses the tramway tracks before joining the main highway, a risk assessment should be conducted to establish whether signalling the highway junction is necessary.

4.25. The highway traffic signals and signs required for the protection of at-grade crossings on tramways are prescribed in the TSRGD and further guidance is in the TSM. Such signals should be controlled by a road traffic light signal controller which is approved by the DfT. The detailed arrangements should be agreed with the appropriate Highway Authority.

4.26. Highway junctions and intersections with on-street tramways should be treated in a way similar to a normal highway layout. This should comply with the appropriate advice from the DfT as set out in the Manual for Streets. Signals should also be provided where a turning highway vehicle may momentarily encroach on an adjacent tram due to end or centre throw.

4.27. Signs giving warning of the presence of trams should be provided and details of these are in the TSRGD and in LRG 4.0 Signing and Marking of Tramways Guidance.

29 BS EN 16186-5:2021+A1:2023 Railway applications. Driver's cabs - External visibility for tram vehicles

4.28. Where highway traffic signals are provided, the tram should have a level of precedence agreed with the Highway Authority.

Off-Street Tramway Intersections with the Highway

4.29. Intersections between a highway and an off-street tramway should be treated as if they were intersections between a minor highway on which the highway traffic is travelling, and a major highway on which the tram is travelling so it has priority, regardless of the volumes of highway and tram traffic.

4.30. Conventional three-aspect signals for highway vehicles and the tramway equivalent for trams should be used as described in Appendix D of this document.

4.31. A non-signalled intersection between an off-street tramway and a highway should be signed as if the tramway were the major highway. *Stop* or *Give Way* signs should be provided on the highway approaches for highway traffic, with the Tram sub-plate applied as appropriate (as shown in Diagram 778.1 of the TSRGD). If necessary, the relevant warning sign and speed restriction sign should be provided on the tramway approaches.

4.32. Visibility from the minor highway carrying the highway traffic should comply with the DfT Manual for Streets.

Pedestrian Footways and Crossings

4.33. In streets which have high densities of pedestrians, the pedestrians should be encouraged to use defined crossing points over the tram tracks. The crossings should have dropped kerbs and appropriate tactile marking and designed so that they are obviously the safest point to cross the tramway.

4.34. Where safe pedestrian routes are defined, there should be clearly recognised features to aid identification which may include, for example, the type of paving, use of colour differentials, texture, differences of levels signing, pedestrian signals, dropped kerbs, pedestrian guard rails or planters etc. to enhance visibility. This identification also needs to consider those with visual or other impairments.

4.35. Crossing points on a tramway should be co-ordinated with the crossing points of any shared or adjacent carriageways. On off-street tramways, the preferred arrangement is to separate entirely the crossing points for any highway from those for the tramway, but if not separate, the arrangements for pedestrian crossings of on-street tramways should be used over those used for a highway crossing.

4.36. All designated crossings of tram tracks should be designed and operated with the needs of mobility and visually-impaired people in mind. Refer to LRG 8.0 Guidance in the Management of Vulnerable Persons for further information.

4.37. Standard TSRGD pedestrian signals should be used at places where the normal passive signing at pedestrian and other foot crossings is inadequate. Any need for signalling and / or audible warning will depend on factors such as visibility and tram and pedestrian traffic flow.

4.38. Where the platforms or tramstops lie in the centre of the highway and those boarding or alighting from a tram have to cross one or more lanes of highway traffic to reach or leave the designated access point for the tramstop or platform, those crossing points should be treated as pedestrian crossings.

4.39. Careful consideration should be given to both visibility of pedestrians by tram drivers (and other highway traffic) and visibility of approaching trams (and other vehicles) by pedestrians.

4.40. Further information is given in relation to pedestrian crossings in document LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users and LRG 24.0 Pedestrian Safety Guidance.

Crossing Layouts

4.41. Where reasonably practicable, the crossing over the tram track should not be aligned with any other separately-signalled pedestrian crossing or separate zebra crossings.

4.42. Where fencing or pedestrian guard rails are required, they should be provided to highway design principles that guide pedestrians to face oncoming trams before they enter the tramway crossing hazard zone, or to direct their attention to pedestrian crossing lights. Consideration should be given to visibility of pedestrians by tram drivers, for example, sighting through fencing such that's when viewed at an acute angle it does not form a solid barrier.

4.43. Part or all of such pedestrian crossings may be unsignalled if the circumstances at the site allow. For example, if the visibility along the tram tracks is good, it may be possible to dispense with pedestrian signals when other circumstances (such as a high volume of adjacent highway traffic or obstructions) would dictate that the highway crossing would be signalled. At other places it may be necessary to provide pedestrian signals across the tramway, but a zebra crossing may be sufficient across the highway.

Pedestrian Crossings Connected to Tramway Signals Linked to Approaching Trams

4.44. Where the tramway crossing can be separated from the remainder of the highway crossing by the provision of refuges, or where the pedestrian crossing movement is parallel to the highway over tram tracks only, i.e. where an off-street or segregated on-street tramway crosses or enters a highway, an audible warning of an approaching tram should be given.

4.45. The warning should be visual for consistency with highway practice. A conventional red / green man pedestrian signal should be used where there are signals controlling tram or highway traffic at the location concerned.

4.46. Audible warnings should only be provided at crossings where this would be consistent with highway practice for such locations.

4.47. The design of any tactile surfaces should follow DfT guidance[30].

30 Guidance on the use of tactile paving (2021): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1046126/guidance-on-the-use-of-tactile-paving-surfaces.pdf

Cycle / Tramway Interface

4.48. Refer to LRG 19.0 Cycle Tramway Interface Guidance for further information.

Road Safety Audit

4.49. A Road Safety Audit (RSA) should be conducted when either a new tramway alignment is constructed or a highway is integrated with an existing tramway. An RSA should be conducted in conjunction with the local Highway or Roads Authority, taking into account the guidance for undertaking an RSA published by National Highways[31].

4.50. GG119 does not consider tramways and it is important that the scope for an audit takes into account the aspects to be considered for the safe operation of trams on the highway.

4.51. Refer to LRG 41.0 Road Safety Audit (RSA) Guidance for further information.

Frontagers

4.52. The needs of premises fronting the tramway for access, loading and maintenance, should be carefully assessed, including those who do not front the tramway but whose only access to the highway is immediately onto the tramway. This consideration should be made when siting OLE.

4.53. It may be necessary to provide dedicated loading / unloading and private parking bays as existing and / or alternatives in another location to avoid the potential for the Tramway Path to become obstructed by vehicles.

4.54. Obstructing a tram track can normally be made an offence under the Powers authorising the construction and operation of the tramway (for example within a TWA or TAWS Order) or by means of relevant by-laws.

4.55. Where the tramway crosses entrances to or exits from premises, it should not be necessary to erect warning signs at each such location. Highway traffic signals may be necessary at busy locations or where sight lines are inadequate.

4.56. If the location where a tramway crosses an entrance where there are likely to be drivers unfamiliar with the area (for example a hospital or visitors to a factory), warning signs may be required.

Public Utilities

4.57. Public utilities in or under the highway should, where possible, be accessible while trams are operating. Any access covers should have their nearest edge at least 500 mm from the edge of the SE. Where pipes and cables have to pass under the track, they should be ducted or sleeved before the tracks are laid, to facilitate maintenance or renewal.

4.58. The design of the tramway should be designed in consultation with the relevant public utility owners from an early stage of development.

31 GG 119 Road Safety Audit: https://www.standardsforhighways.co.uk/search/710d4c33-0032-4dfb-8303-17aff1ce804b

4.59. Further information in relation to stay current is provided in Section 7 of this document and in LRG 15.0 Stray Current Management Guidance.

4.60. In relation to Electromagnetic Compatibility (EMC), information is provided in LRG 3.0 Management of Electromagnetic Compatibility (EMC) Guidance.

Changes Between Segregated and Integrated On-Street Tramways and Off-Street Tramways

4.61. Where a tramway joins, leaves or runs alongside a carriageway, it should be identified by appropriate signing, carriageway markings or traffic signals in accordance with the TSRGD.

4.62. Access to the off-street or segregated on-street sections of tramways by highway vehicles other than trams should be deterred by traffic signs, which may be supplemented by TROs or by-laws etc. Consideration could be given to active signage and markings, for example, active road markings, coloured cats eyes, rumble strips or other deterrents.

4.63. Suitable treatment of the highway surface leading to a wholly segregated section of track, for example, ballast, flexible or frangible bollards or other anti-highway vehicle measures between the tram tracks (potentially with a lower than normal clearance to the tram being permissible) or isolated cobbles set into the surface, may also help to clearly identify the tramway and encourage compliance with the signs.

Tramway Path

4.64. The tramway path is the area reserved for a moving tram in its environment. It is derived from the SE by adding the minimum appropriate clearance. It therefore depends upon the SE and the nature of the operational environment and the structures and features within this environment.

4.65. It is important at an early stage to determine a tram's SE at various speeds. This is particularly relevant for low speed areas, such as through platforms, to ensure that overly-cautious clearances are not adopted.

4.66. The path of an on-street tramway should be clearly marked where it is not easily apparent from the carriageway or kerbs and where it would be useful either to tram drivers or other highway users to do so (including where there is on-street parking). Where such marking is necessary, this may be achieved by the use of colour differentials, texture or differences of levels to enhance visibility, and should be consistent with the prescribed markings shown in the TSRGD.

4.67. If yellow dot markings are to be continued through any yellow box markings at junctions, this marking may require an amendment to the yellow box markings.

4.68. If more than one type of tram is to be used on a system, the tramway path at any point should be determined by the characteristics of the tram type that has the widest SE at that point.

4.69. Where two tracks are parallel to each other or converge, they should be enclosed within a single tramway path.

4.70. Kerbs may be required to separate a segregated on-street track from an adjacent carriageway unless highway vehicle barriers or a similar measure are installed to separate highway vehicles

from oncoming trams, or to protect against collision of highway vehicles with isolated lineside structures.

Pedestrian Protection Arrangements

4.71. Pedestrian guard rails may be used to direct pedestrians to safe crossing points. These guard rails should be appropriately set back from the tramway to avoid creating trapping points.

4.72. Suitable fencing should be provided at places on the tramway where there is a significant risk to pedestrian safety. Access to the track, except at designated crossings, should be discouraged as far as possible.

4.73. Appropriate forms of deterrent paving may be used to discourage both pedestrian and vehicular access to appropriate areas of the tramway.

4.74. In areas where pedestrians have access, or where there is street furniture, adjacent infrastructure or access for tramway infrastructure maintenance, tram operating speeds should be designed to reflect the requirements for line of sight operation.

4.75. Further information on pedestrian protection is given in Appendix E, LRG 24.0 Pedestrian Safety Guidance and the Manual for Streets.

5. Tramway Infrastructure

5.1. This section provides information on the infrastructure of the tramway system including the identification of track, bridges, tunnels and other infrastructure and is in line with UK good practice.

The Track

5.2. Steel running rails should conform to the appropriate standards such as BS EN 14811[32] or BS EN 13674-1:2011+A1:2017[33]. The rail section(s) and materials, and wheel profile(s) should be carefully selected so as to be mutually compatible in terms of derailment prevention, ride, noise, wear, adhesion and maintenance. Consideration should also be given to other rail compositions which may offer additional benefits in some circumstances. Refer to BS EN 17636:2023[34] and LRG 38.0 Noise and Vibration Guidance for further information.

5.3. Consideration will need to be given to adhesion levels achievable with new rails. Generally these levels should improve with use.

5.4. Magnetic properties of the rail will affect the performance of electromagnetic track brakes.

5.5. Grooved rails should have sufficient and suitable drainage provided at appropriate intervals and locations (such as areas of ponding, bottom of gradients, in front of switch tip to prevent as far as possible debris being washed in the switch blades.). When laid in the highway they should be connected to surface water drainage systems which may have a significant effect on highway drainage.

5.6. The drains should be capable of being easily cleaned to allow removal of sand and other debris. The provision of drainage slots should not render the rail incapable of providing sufficient support or guidance for trams.

5.7. Where rails are laid in a carriageway that is used by rubber-tyred vehicles travelling on the same general alignment as the rails, the effect that the steel rail and any flexible filling will have upon the skid resistance of the carriageway surface should be considered, particularly when vehicles move across or along the carriageway and their tyres cross over the rails at shallow angles. It is particularly essential to consider the movement of two wheeled vehicles and cycles.

5.8. Rails in polymer should take account of the potential for the rails to move differentially within the polymer. A means should be provided to fix the track gauge.

5.9. The track should be located within the carriageway so that, so far as is reasonably practicable, it does not coincide with the path normally taken by the wheels of rubber-tyred vehicles, for example, locate track in the centre of the carriageway will encourage road vehicles to straddle the rails.

32 BS EN 14811:2019 Railway applications. Track. Special purpose rail. Grooved rails and associated construction profiles

33 BS EN 13674-1:2011+A1:2017 Railway applications. Track. Rail. Vignole railway rails 46 kg/m and above

34 BS EN 17636:2023 Rail applications. Infrastructure. Track Alignment Design parameters. Urban rail

5.10. Additional warnings of the risk of skidding may need to be given to motorists as rubber-tyred vehicles may skid when accelerating, braking or cornering.

5.11. The carriageway incorporating the tramway should be engineered to present a surface which provides the following:

- Can support the normal loads of vehicles using the carriageway; and
- Has a seal to minimise the ingress of water at the interface between rail and adjacent highway surfaces, where such ingress could cause damage to the highway surface, for example, due to the forming of ice.

5.12. Where flexible filling material is used it should, so far as reasonably practicable, have a skid resistance comparable with the adjacent highway surface material.

5.13. In the case of integrated on-street tramways, so far as is technically feasible, the head of the rail should be level with the adjacent highway surface when first laid.

5.14. In relation to rail breaks, refer to LRG 22.0 Guidance on the Management of Embedded and Grooved Rail Breaks for further information. In relation to the wheel rail interface, refer to LRG 16.0 Wheel Rail Interface Guidance.

Track Geometry

5.15. The maximum horizontal and vertical curvature, the maximum gradient, the maximum track twist on a tramway, and combinations thereof should be established taking account of the following (not exclusively):

- Physical constraints of any route;
- Capability of the tram; and
- Effects of speed, curvature and gradient on the passengers.

5.16. The horizontal curvature of sections of the tramway should be designed with the highest radius possible and appropriate mitigation in place for any consequence of flange climb, overspeed derailment or overturning. Any mitigation should consider as a minimum the following (not exclusively)

- Advance warning signs and speed limit warnings as defined in TSRGD;
- Avoidance of lineside equipment boxes, drainage inspection covers etc. in the vicinity of curves; and
- Provision of automatic speed control.

5.17. Geometric limits should not be set too severely on the infrastructure as they may create restrictions on the types of trams that can operate over the whole route / network.

5.18. Where circumstances permit, super elevation (cant) might be considered on the tram track and the cross section of the highway should be designed to accommodate this, noting that in some locations, the cant in some directions may work against the cant of the highway and therefore may not be achievable.

5.19. There shall also be consideration of whether surface water drainage can be directed away from the grooves in the rails by providing a cross-fall.

Tramway Points in the Highway

5.20. Points should not be located without other protection measures where the movement of the blades would cause a hazard to other highway users including cyclists and pedestrians, or where highway vehicles could damage the points. Consideration should be given to the safety of the use of the following:

- Lift over crossings;
- 90-degree crossings; and
- Flange running.

5.21. The moving blades of the points should not normally be located at the following locations:

- At places in the street where there are concentrations of pedestrians, such as at formally identified tramway / highway crossings;
- Where there would be a particular danger to pedestrians, cyclists or motorcyclists; or
- In busy traffic, or where traffic lanes cross or merge with a tram lane, particularly where this is also aggravated by a turning movement.

5.22. Pre-sorting points with interlaced track or double-headed rails or other techniques may be used where practicable to avoid hazards to other highway users.

5.23. Where points have to be located at the more hazardous locations identified above, special precautions may be necessary to minimise risk (refer to Section 8 and also Appendix A of this document).

5.24. Careful consideration is to be given for safety of tram drivers operating manual and / or failed points.

5.25. The point indicator and point detection circuits should be designed to meet inherently fail safe criteria where a point indicator is the primary means used to allow a tram to approach facing points at a speed higher than that which would allow the driver to observe the lie of the points, and stop in advance of an incorrectly set route or misaligned point blade.

5.26. There should be an additional indication for an out of correspondence point condition (where the point blades are not in the position selected to allow a safe tram movement) which should be a horizontal bar. UK tramways use bespoke point indications that are not a prescribed form. However, some examples are set out in Appendix D. Consistency of approach needs to be maintained throughout each individual network.

5.27. If point blades are misaligned or an incorrect route is set, a tram that cannot proceed should not obstruct other trams (other than a following tram) or other highway traffic. Where the points are some distance beyond the highway junction, a suggested appropriate arrangement is shown in Appendix A.

5.28. Where points are located in off-street sections of the tramway, provision should be made to deter access to those areas where the moveable portion of the points would cause a hazard. Sprung points should be used where possible.

Bridges and Viaducts

Bridges Carrying the Tramway

5.29. Bridges or viaducts carrying tramways should be designed using appropriate methods and loading assumptions, including for other highway vehicles as appropriate and multiple tram vehicles during emergency stabling.

5.30. Designers who choose to follow the Eurocode process should note that the standard load models in BS EN 1991-2:2023[35] are all for railway cases and are unlikely to be suitable for the lower static and dynamic loads generated by trams without some modification. If a standard BS EN 1991-2 load case is used, then a suitably justified use of a reduced factor **α** will be necessary.

5.31. Adequate derailment containment should be assessed and sufficiently provided on all bridges and structures.

Bridges Over the Tramway

5.32. Bridge parapets should be adequate to prevent access to the live overhead electrical traction power system.

5.33. Bridges and supporting structures over the tramway should be capable of resisting credible impact forces from derailed trams. Designers should be able to demonstrate that they have used risk based kinetic energy values in developing the design.

Tunnels

5.34. Lighting in underpasses and tunnels should be provided when either side is not already lit by street lighting. This is in addition to the provision of lighting for use on an emergency basis for evacuation, which may also assist maintenance of the tramway.

5.35. If the tunnel is shared with other traffic of any kind, then it should meet current highway design standards.

5.36. Where the tunnel is for tram use only and other highway or railway users are excluded, then the design of the tunnel should reflect the assessment of the tramway hazards as the risk profile is likely to be lower.

5.37. Where a new twin-track tramway tunnel is constructed, then this should be designed to provide side walkways of at least 700 mm width. If this is not possible for existing tunnels, then a walkway as wide as reasonably practicable should be provided. Operational procedures may be required to allow safe egress from a failed tram within a tunnel.

35 BS EN 1991-2:2023 Eurocode 1. Actions on structures. Traffic loads on bridges and other civil engineering works

5.38. For new or existing single-bore tunnels, a side walkway of 700 mm minimum should be provided with additional space on the opposite side of the tram of at least 460 mm to allow staff access.

5.39. Where former railway tunnels are used, in the event of a detrainment, if it is not possible to provide adequate walkways on both sides, the space should be used to provide one centre walkway with a generous width.

5.40. Where the size of a former railway tunnel does not allow for any walkway to be provided, then the track may be used as a walkway for emergency access and maintenance only if the following can all be adequately provided:

- There is sufficient clearance for the tram doors to open and allow passenger egress;
- The track provides an acceptable walking surface;
- The tunnel is illuminated (at all times or with emergency lighting if controlled by tramway staff); and
- The tramway operates on line of sight through the tunnel.

5.41. It should be possible to sustain emergency lighting at not less than 5 lux for at least the time required for an evacuation and not less than 3 hours.

5.42. If all of the above conditions cannot be met, the operator will need to ensure that the findings of a thorough risk assessment are reflected in the SMS and operational controls.

Tramway Access Control

5.43. A tramway that is operating on line of sight principles generally has no restriction on access to it for pedestrians. However, where there is the potential for particular risks to occur or sightlines / sighting times are restricted, then a risk assessment should be undertaken to select appropriate deterrent measures and other measures such as speed limits and lighting etc. and anti-pedestrian devices and change from on to off-street and underrun protection and extension at tramstops.

5.44. Of particular importance is the prohibition and protection of unauthorised people from the electric traction system. Such preventative and protective measures should be designed with the needs of the particular environment (and therefore risks) in mind (refer to Section 7).

5.45. The design of the tracks, paving, OLE and other infrastructure associated with the tramway should take account of the needs and safety of pedestrians, cyclists and other highway users, and in doing so, make appropriate provision for their safety.

5.46. While the tramway is normally unfenced, in some locations fencing or other barrier may be required to segregate or direct pedestrians away from it, or to prevent access to it, whilst also accommodating desire lines for pedestrians and cyclists.

5.47. Special consideration should be given to the needs of mobility-impaired people, whether on foot or in wheelchairs, or using pushchairs; refer to LRG 8.0 Guidance in the Management of Vulnerable Persons for further information. As suggested above for cycle groups, there may be local groups who may be able to provide useful information and feedback on the most effective measures or solutions for the tramway route under development. Refer to LRG 19.0 Cycle Tramway Interface Guidance for further information.

5.48. Where the need for a segregated tramway has been established, deterrents to access should be provided to discourage trespass by both pedestrians and highway vehicles. Promoters should include suitable powers within the TWA or TAWS Order to provide for enforcement for trespass.

Identification of the Infrastructure

5.49. A means of identifying any location or structure along the tramway should be produced, for example, by numbering the overhead line supports.

5.50. All bridges and other fixed structures, as appropriate, should be uniquely and conspicuously identified.

5.51. Any system of identification should be unique, alpha-numeric and agreed with the local Highway Authority where necessary.

Terminating Tracks

5.52. Where tram tracks terminate, arrangements should be made for any potential tram that overrun the normal limit of operations to be brought to a halt or contained safely. The arrangements may include (not exclusively):

- Sand drags;
- Soft macadam surfacing over the rails; or
- Energy-absorbing architectural features.

5.53. The selection of the arrangements for a location should be on the basis of tram kinetic energy, the risks arising from an overrun, and suitability for the surrounding environment. The means chosen should discourage pedestrians from lingering in an overrun area.

5.54. Without proper consideration of energy absorption rates and compatibility with trams the provision of tramway and stops could increase risk.

6. Tramstops

6.1. This Section provides information on tramstops and is in line with good practice.

6.2. For the purposes of this document, the term 'tramstop' includes tramstops with a raised platform above footway level and those with platforms at pavement level.

6.3. In relation to pedestrian issues, refer to LRG 24.0 Pedestrian Safety Guidance for further information.

Tramstop Location

6.4. The needs of passengers, pedestrians and other highway users should be reflected in the design of tramstops and associated pedestrian routes. Design factors include the following (not exclusively):

- Sightlines;
- Gradients and curvature;
- Lighting;
- Pedestrian desire lines; and
- Destinations within close proximity such as rail stations, schools, sporting venues etc.

6.5. There are a number of factors that should be considered in the siting of tramstops which include the following (not exclusively):

- Adequate visibility of approaching trams and highway traffic for people who cross the highway to access a tramstop;
- Tram drivers have adequate visibility of a tramstop;
- Tram drivers have adequate visibility of people at or approaching or leaving a tramstop;
- Other highway vehicle drivers have adequate visibility of pedestrians approaching or leaving a tramstop; and
- There is sufficient space for pedestrian flows.

6.6. After a risk assessment, if visibility in and around the tramstop is thought to be poor, then crossings equipped with pedestrian signals may be considered appropriate.

6.7. When tramstops are located on gradients, consideration should be given to the difficulties that might be created for those who are mobility impaired. Mobility-impaired people are a very much wider group than wheelchair users and include, for example, people with prams and pushchairs have the same need for level access. Refer to LRG 8.0 Guidance in the Management of Vulnerable Persons for further information.

Tramstop Platforms

6.8. Platforms are either located at either side of the tramway ('side platforms') where they serve each direction of travel separately, or 'island platforms' where they are positioned between the two sets of tracks.

6.9. Side platforms may form part of the footway or other public areas that are accessible to pedestrians.

6.10. Island platforms can be designed to accommodate smaller widths of land than side platforms, but have the disadvantage that passengers will always have to cross one track to access them. In addition, there may be limited space for waiting passengers and tramstop facilities, such as information on travel direction and timetables etc., and so will need careful design to avoid confusion.

6.11. Platforms should, where possible, be located on straight sections of track ideally at a radius of no less than 1000m.

6.12. Platforms should be provided with a tactile surface and a platform edge marking strip and these should follow DfT guidance. Platform surfacing should provide contrast to the edge marking and a suitable level of friction.

6.13. Platform length should be sufficient to match the passenger door arrangements of the longest tram or normal combination of trams using the part of the system on which the tramstop is located.

6.14. The length of the platform should include an allowance for inaccurate stopping. The consideration that may need to be give could include the need for the tram to interact with the following:

- Signalling system;
- Pedestrian crossings;
- Points;
- Boarding points;
- Fouling points;
- Section insulators; or
- Recharge points.

6.15. To ensure compliance throughout the life of the scheme / tramway, adequate wear and maintenance tolerances should be considered in the design of the platform.

6.16. Where access for mobility impaired people is provided only at some doors, adequate signage should be provided both within the tram and on the platform to indicate the door or doors where this is provided. Refer to LRG 8.0 Guidance in the Management of Vulnerable Persons for further information.

6.17. Consideration should be given to indicating on the platform the vicinity of the couplers in systems where double tramcars are routinely used in order to highlight that this is a potential area of risk.

Platform Height

6.18. Platform heights of nominal height of 300 mm are becoming common for platforms and therefore this may also be the most appropriate choice for any new tram system.

6.19. Where the height difference between platforms and any adjacent footway is more than 400 mm, the non-tramway edge may need to be fenced. Continuous steps may be provided instead of a fence with the appropriate tactile markings.

6.20. Differences in height between tram floor and platforms shall not exceed 50 mm at doors which are intended to be used by mobility-impaired passengers (RVAR).

Platform Width

6.21. Platform width should give adequate unobstructed space for passengers boarding and alighting from the tram and should also take into account pedestrian movements along the platform and the likely accumulations of waiting passengers, especially if the platform also forms part of the footway. Consideration should be given to congestion that is likely to be caused adjacent to ticket vending machines and underneath any shelters.

6.22. The minimum width between the tramway edge of the platform and any structure on the platform, except for the roofs of shelters, should not be less than 1500 mm.

6.23. An island platform (one that lies directly between two tramway tracks) should normally be at least 3000 mm wide.

Platform Clearances

Between Platforms and Trams

6.24. Horizontal clearance between platforms and door thresholds shall not exceed 75 mm at doors which are intended to be used by mobility-impaired passengers. It is recommended that a figure of 40 mm is achieved at installation to help ensure compliance with the RVAR over the life of the system.

6.25. The amounts by which the kinematic envelope (refer to Section 3) will be increased to form the SE are speed dependent and therefore, the gap between the tram and the platform is also speed dependent. Constraining this increase by the platform edge may require the imposition of a speed restriction through the tramstop.

6.26. No shelter, sign or other structure on a platform should encroach within 450 mm of the edge of a carriageway used by other highway vehicles.

6.27. Where a side platform has highway traffic adjacent to the non-tramway side, a fence or barrier should be provided if normal highway design standards require it.

Vertical Clearance

6.28. There should be clear headroom of at least 2300 mm along the tramstop. This applies to any shelters, signs and or any other structures on a platform.

6.29. Shelters, signs and other structures on the platforms should be designed to prevent access to OLE equipment.

Lighting at Tramstops

6.30. Tramstops should be adequately and uniformly illuminated during the hours of darkness to a level commensurate with the surrounding area and as required by CCTV. The use of light emitting diode (LED) lighting should be utilised.

6.31. Lighting levels should be to the levels recommended in the appropriate section of BS 5489-1:2020[36].

6.32. The illumination of the tramstop may solely be provided by adjacent carriageway lighting.

Access to Tramstops

6.33. A safe and convenient access route should be provided to tramstops for all people, including those who are mobility-impaired. Refer to LRG 28.0 Guidance on the Provision of Accessibility in Light Rail Systems and 8.0 LRG 8.0 Guidance in the Management of Vulnerable Persons for further information.

6.34. The design of tram infrastructure adjacent to platforms and pedestrian crossings at tramstops should aim to minimise injury in the event that a person is struck by a tram. Therefore, the surrounding surface should be at a level relative to the rail that allows the tram's pedestrian underrun protection to operate effectively, for example, either by ballasting to rail level or other flush surfacing. This surfacing should also extend on the approach and departure to a tramstop for a suitable distance, which is based on the tram braking performance and likely tram speed in the location.

6.35. Where access to a tramstop is by ramp from an adjacent highway bridge, if the slope is 1 in 20 (5%), the length of the ramp will be in the order of 100 m where the highway is over the tramway, and 160 m where it is under it. Intermediate flat landings will increase these ramp lengths by 20 m to 30 m. The total length of such an access may therefore be considered to be excessive by the more elderly or mobility-impaired people and lifts may have to be provided.

6.36. For information relating to crossings refer to LRG 24.0 Pedestrian Safety Guidance and LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users.

36 BS 5489-1:2020 - Design of road lighting. Lighting of roads and public amenity areas. Code of practice

7. Electric Traction Systems

7.1. This Section provides information on tramway electric traction systems and is in line with the above and UK guidance, standards and regulations. Refer also to LRG 21.0 OLE Maintenance and Reference Manual

7.2. Trams should usually be supplied with electric traction power from overhead line systems at a voltage consistent with BS EN 50163:2004+A2:2020[37].

7.3. 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[38] and subject to risk assessment.

7.4. 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.

7.5. In the urban realm, consideration should be given to attaching OLE to buildings.

Overhead Line Equipment (OLE)

7.6. 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 highway vehicle or tram. Ideally, towards the rear of any pedestrian footway.

7.7. 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 rear of the footway.

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

7.9. 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 highway users, or if the location is particularly sensitive. In order to do this, sufficient Powers (for example, through a TWA or TAWS Order) would have to be in place, and the building to which the OLE is being attached would have to undergo sufficient surveying and testing to confirm the tension can be supported.

7.10. For general clearance requirements to electric traction poles refer to Section 3 and also Appendix G of this document.

7.11. All electric traction poles should be resistant to climbing and the use of deterrent measures should be considered where practicable.

37 EN 50163:2004+A2:2020 Railway applications - Supply voltages of traction systems
38 Electricity at Work Regulations 1989: https://www.legislation.gov.uk/uksi/1989/635/contents

7.12. 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.

7.13. Structures supporting the OLE and not bonded to the traction return (refer to IEC 60913:2013[39] and BS EN 50122:2022[40]) should be at least double-insulated from live components. The primary insulation should be as close as possible to the live conductors.

7.14. 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 to BS EN 50345:2009[41] in the contact wire support system of the OLE.

7.15. Refer to LRG 40.0 Overhead Line Systems Training and Competency Guidance in relation to working on or near OLE.

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

7.16. The design of the overhead contact wire 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 highway vehicle, may release tension in the overhead line system. However, the design should be sufficient to allow other supports to prevent live equipment from sagging below 5.2m in a public area, refer to the Electrical Clearance Section below. When off-street it may sag lower, provided that it remains out of reach of pedestrians.

7.17. 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

7.18. 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.

7.19. Such precautions may include, for example, double insulation and voltage limiting devices (VLDs) in respect of the different electrical systems or specially designed earthing systems.

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

39 IEC 60913:2013 Railway applications – Fixed installations – Electric traction overhead contact lines

40 BS EN 50122:2022 Railway applications. Fixed installations. Electrical safety, earthing and the return circuit Protective provisions against electric shock

41 BS EN 50345:2009 Railway applications. Fixed installations. Electric traction. Insulating synthetic rope assemblies for support of overhead contact lines'

Management and Safe Operation of Power Supply

7.21. The design of the electric traction power supply system should be compliant with BS EN 50122:2022 Parts 1, 2 and 3. This should include lightning and surge protection.

7.22. Remotely operated 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.

7.23. 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.

7.24. 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.

7.25. 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 highway or tram traffic, and should not be able to be interfered with by highway traffic or the public. Examples include the following (not exclusively):

- Motorised isolators;
- Manual isolators; and
- Designated Earthing Points (DEPs), etc.

7.26. 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.

7.27. High-speed DC (direct current) 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 of these breakers should not normally be used.

Sectioning

7.28. 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.

7.29. 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

7.30. 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 (refer to Section 8 of this document).

7.31. There should be a monitoring system (such as that provided by SCADA (Supervisory Control and Data Acquisition)) 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.

7.32. 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 by an emergency button in the control room.

7.33. 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 do the following:

- 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

7.34. 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 50122-1:2022[42].

7.35. 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. Protection measures should include the use VLDs or similar.

7.36. 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

7.37. Where the running rails are used for the return of electric traction current the along-track resistance should be designed and maintained to be as low as possible, 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.

42 BS EN 50122-1:2022 Part 1 Railway applications. Fixed installations. Electrical safety, earthing and the return circuit. Protective provisions against electric shock.

7.38. Refer also to LRG 15.0 Stray Current Management Guidance.

Minimisation of Leakage of Stray Current to Local Earth

7.39. 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.

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

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

7.42. 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.

7.43. Refer to LRG 15.0 Stray Current Management Guidance for further information on the management of stray currents.

7.44. In relation to electromagnetic compatibility, further information is available in LRG 3.0 Management of Electromagnetic Compatibility (EMC) Guidance.

Electrical Clearances

7.45. The appropriate clearances for tramway systems are defined in BS EN 50119:2020[43] and BS EN 50121-1:2017[44].

Height

7.46. The height of the contact wire or any other live part of the overhead electric traction supply system shall not be less than 5800 mm above the surface of any carriageway at the maximum temperature of the wire[45].

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

7.48. 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 shall 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. Any proposal to use a lower position (for example, because of an existing bridge) would require specific statutory authority or an exemption from the SoS.

43 BS EN 50119:2020 Railway applications. Fixed installations. Electric traction overhead contact lines
44 BS EN 50121-1:2017 Railway applications. Electromagnetic compatibility. General
45 Refer to The Electricity Safety, Quality and Continuity Regulations 2002

7.49. 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.

7.50. Where the headroom below the contact wire is reduced, the safe height should be indicated on highway traffic signs (shown in Diagram 779 of the TSRGD) both in advance and also at the location of the reduction.

7.51. 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 heigh 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

7.52. 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 OLE for the passage of a high load.

8. Control of Movement

8.1. The movement of trams need to be controlled in order to prevent collisions and also to prevent potential derailments on points and crossings and at other high risk locations.

8.2. Line of sight driving is normally used on tramways. Under this mode, a tram should be able to stop before a reasonably visible stationary obstruction ahead from the intended speed of operation, by using the service brake. Such obstructions include a signal displaying a *Stop* aspect, or the points indicator displaying an inappropriate aspect for the intended or expected route etc. A documented assessment should be undertaken that includes the following (not exclusively):

- Available sighting distance;
- Intended speed of operation;
- Braking performance of the tram, taking into consideration the gradient and tram brake equipment response time;
- Effectiveness of illumination of the track ahead during times of darkness;
- Expected driver reaction time, which will depend upon what other actions the driver is expected to be carrying out at the location;
- Visibility and clarity of signals and points indicators;
- Topology of the surrounding area including side highways / walkways and crossings for non-motorised users;
- Surrounding amenities, such as mainline rail stations, playing fields, schools, residential care homes;
- Geometry of the tramway alignment;
- Provision of any form of active warning system; and
- Areas of low adhesion potential.

Bi-Directional Single Line Sections

8.3. There is no requirement for signalling to be provided where the visibility has been assessed and is considered adequate from one end of a single line section to the other. In such consideration, the driver can be adequately relied upon to assess whether a tram in the opposing direction has entered, or is about to enter, the single line section.

8.4. In the case of no signals being present, a rule regarding precedence of occupation of the section is appropriate and should be reinforced by signs.

8.5. Where the distance of the single line section exceeds the driver's forward visibility or geometry or structures intervene, then signalling controls should follow highway principles for directionality. If necessary, these should be reinforced by Signal Passed at Stop (SPAS) indicators to show that a tram has entered an occupied section from the opposite direction.

8.6. The operation of trams in single track sections should always remain as line of sight, and drivers should be prepared to stop on seeing an approaching tram. They are not required to have a level of safety integrity commensurate with mainline railway signalling principles for single line sections.

8.7. However, if appropriate to the risk, railway signalling principles may be used to provide a higher level of safety integrity if necessary on off-street sections.

Integration of the Tramway and Highway

8.8. The design and integration of the tramway and highway should take account of the following factors that could affect the safe operation of the tramway (not exclusively):

- Actual pedestrian desire lines and cycle crossing points (refer to LRG 19.0 Cycle Tramway Interface Guidance and 24.0 Pedestrian Safety Guidance for additional information);
- Design of pedestrian routes so as to encourage pedestrians to face towards any oncoming tram before crossing the track (refer to LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users);
- Design and location of parking bays, equipment cabinets, overhead line poles, vegetation and other street furniture and features, so as to avoid places of concealment of pedestrians or that they will not see an approaching tram;
- Provision of barriers between places of concealment and the SE;
- Design of access routes to and from tramstops so that passengers are discouraged from crossing the track at places other than designated crossing points;
- The safe and efficient passage of other highway vehicles over and around the tramway;
- Intervisibility between approaching trams and highway vehicles emerging onto the tramway or into the SE;
- The creation of one-way streets to prevent highway vehicles emerging from junctions where the sight lines are particularly poor;
- Relocation or revision of existing access and loading arrangements for frontagers and those whose access is immediately from the tramway;
- Speed restrictions, on both trams and other highway traffic;
- Audible warning by approaching trams;
- Measures to deter pedestrian access to some areas;
- Warning signs for those approaching the tramway;
- Elimination of features likely to distract tram drivers or divide their attention;
- The turning radii of highway vehicles manoeuvring in the vicinity of the tramway path; and
- Levels of illumination of tramway junctions with highways should be consistent with normal highway design practice.

8.9. Reference should be made to the appropriate chapters of the TSM.

8.10. Where necessary, conflicting highway and tram movements at highway intersections and places where a tramway crosses a carriageway should be controlled by integrated highway and tramway signalling using an approved road traffic controller.

8.11. Part-time traffic signals may be employed to allow the use of emergency crossovers and other infrequently required tramway routes on the highway. The appropriate signing for part-time traffic signals on the highway as given in the TSRGD should be provided. This may need to be

supplemented by additional signage giving more information to other highway users on potential 'unusual' tram movements which could include reversal of trams in the highway. Refer also to the Reversal Running section below.

8.12. Where it is necessary to control the movement of trams during highway works or tramway maintenance, consideration should be given to adapting portable signals to show tram aspects.

Connections Between Tramways and Railways

8.13. Connections between a tramway system and a railway system should be suitably managed and be provided where an operational need has been established.

8.14. If railway vehicles need to operate over a tramway, their compatibility needs to be ensured by the tramway operator and the operation appropriately managed. Similarly, if a tram needs to operate over a railway, the requirements of the railway undertaking will need to be adhered to.

8.15. Apart from the times when movements have been properly arranged through robust controls, connections shall remain secured and out of use.

8.16. Clear maintenance boundaries and responsibilities (including timescales) should be agreed between each Infrastructure Manager involved.

Location of LRT Signals

8.17. On the highway, the layout and positioning of LRT (Light Rapid Transit) signals and the associated staging and phasing at intersections should follow current highway traffic engineering principles as defined in the TSM.

8.18. On segregated sections, the position of LRT signals needs to take account of braking and sighting distances in all environmental conditions.

8.19. On the highway, particular attention should be paid to the requirements of turning traffic in the design, location and staging of traffic signals. Consideration should be given to the visibility of LRT signals such that signals are visible to tram drivers held at *Stop* lines irrespective of the location of other highway vehicles.

8.20. Staggered *Stop* lines may assist with ensuring the visibility of LRT signals to the tram driver.

8.21. LRT signal heads may be placed on either side of the track to optimise visibility from the driver's cab.

8.22. All signs and signals on the highway shall be agreed with the Highway Authority and appropriate TROs shall be in place to ensure they are all prescribed and enforceable.

8.23. Where the tramway track layout allows for the reversal of trams in the highway in a way that would result in the tram moving in the opposite direction to other highway traffic, highway traffic signals to stop other highway traffic while the tram reverses are required. Refer also to the Reversal Running section below.

Tram Detection

8.24. Detection systems should be configured so that the failure of an individual tram detector does not compromise the safe operation of a highway junction or pedestrian crossing.

8.25. If each driving position of a tram is separately identified for route calling and route releasing, then suitable arrangements should be provided to ensure only one driving position is active at any one time under normal operating conditions.

Point Control, Detection and Indication

8.26. Power-operated points can be operated on a tramway by the tram on approach or by a tram management system at a central control point. In public areas, points should only throw when the tram driver is sufficiently close or linked to the tram ready to start control to allow them to determine that no person will be affected by the moving parts, but also in enough time for the tram driver to determine the lie of the points before reaching them. If these points cannot be established to be clear of people, then the tram driver shall not allow the demand for the points to throw to be made. This can be either by operating a control or moving to a position where the driver knows demand would be initiated.

8.27. Where points have the facility to be manually operated by the use of a lever or other such means, access to and operation of such points should not present a risk of personal injury to the tram driver and they should be protected from unauthorised access.

8.28. Where manual points are regularly used as part of normal operating conditions, then the stopping position for the tram should make provision for other highway users so it does not lead to hazards and should allow the tram driver to leave the tram and operate the points in safety.

8.29. Where point indication is necessary, this should be independent of the signalling control system and should be dependent only on the detection of point blades and any locking arrangements. Indication of detection should be by the position of the point blades.

8.30. Where a highway traffic signal is permitting the tram to proceed in only a specifically indicated direction, then it is the responsibility of the tram driver to ensure the correct corresponding lie of any points.

8.31. Off-highway an LRT signal can be interlocked with the lie of points and can be dependent on them. This may help to reduce operational risk.

8.32. On a highway, the request from a tram and / or the Operations Control Centre (OCC) should in all circumstances be capable of being made to the road traffic signal controller independently of the lie of the relevant points. This independence is to ensure that the tram will always get a *Proceed* at a highway traffic junction where it is not legal to pass a signal at *Stop*. (Passing a signal at *Stop* would otherwise normally only be possible under the control of a person holding an authority granted by the Chief Constable.)

8.33. The switch blades (or their equivalent) of any points used in the facing direction should be positively held in position during the passage of a tram. Mechanisms that allow the points to be trailed may be used.

8.34. Where spring force or hydraulic pressure is used to achieve the trailing of points, a speed restriction through the points may be required.

8.35. Points shall be locked such that once they are set for a particular tram and an appropriate indication given to that tram and the points cannot be moved until the whole of that tram has passed over those points.

8.36. An indication of the position of facing or non-trailable points that are used regularly by passenger carrying trams should be given to the tram driver by a visual indicator positioned close to the points.

8.37. Operators may find it useful to have indications of out-of-correspondence points transmitted to a central location.

8.38. Indication is not required for driver operated points in depots.

8.39. Indication is not required for emergency trailing crossovers which become facing only when used, provided that the tram driver can observe the position of the point blades from the driving position before driving the tram over them.

8.40. If the points are incorrectly set or are misaligned, in the interim whilst they are being corrected, the place where the tram should stop should be clearly marked. If this is not immediately before the points, the point indicator may be duplicated at the stopping point.

Reversal (or 'Wrong Direction') Running

8.41. In general all vehicles on the highway shall keep to the left side of the highway (Highway Act 1835, Section 78[46]) unless they have statutory authority to do otherwise, for example, through a TWA or TAWS Order.

8.42. Temporary, emergency wrong direction movements (reversing) on the highway, i.e. those not authorised by statute, shall only be made when necessary for safety or to permit trams to turn during an emergency operation. The distance of wrong direction / reversal operation should be minimised and fully risk assessed prior to making this manoeuvre, the driver shall be in the leading cab. On such occasions passing signals at stop at highway junctions need to be authorised by the police.

8.43. There is no requirement to have such wrong direction moves authorised by a police officer, but drivers of trams should take appropriate care. The operator should have written procedures for wrong direction moves that are documented within the SMS. Also refer to The Road Vehicles (Construction and Use) Regulations 1986, Regulation 106.

8.44. Authorisation from the police will be required for wrong direction moves along one way streets.

8.45. When wrong direction operations may be required for an extended period, operators should come to agreement with the relevant local Highway Authority over the most appropriate arrangements for the safe control of other highway users.

46 Highway Act 1835: http://www.legislation.gov.uk/ukpga/Will4/5-6/50/contents

8.46. Highway traffic signals will be required in order to stop the other highway traffic while a tram is making a wrong direction movement.

Design and Construction of Tramway Points, Signals and Other Indicators

8.47. Careful consideration and choice of track components for points and crossings on a tramway should be made to ensure compatibility with tramway point mechanisms and equipment.

8.48. For normal operating conditions, point mechanisms should be trailable. Mechanisms that are not trailable can present a significant derailment hazard to a tram if run through.

8.49. Where point position indicators are used these should ideally conform to a format such as the UK examples set out in Appendix D.

8.50. An LRT signal should be provided for the trams at all highway traffic signalled installations for each direction from which a tram may approach.

8.51. Two or more trams should not normally operate through a signalled highway junction consecutively in the same direction and within the same phase. Any proposal to do so should be based on two successive tram *Proceed* phases within the same stage of the junction signalling.

8.52. Traffic signals applicable to tramways shall comply with the TSRGD that defines the appropriate signs and signals that a tram driver shall obey. Further information on signs is given in the TSM.

8.53. The prescribed LRT signals for on-street tramways should ordinarily be used throughout systems to ensure consistency i.e. also to be used on segregated sections of the tramway.

8.54. Consideration should be given to the provision of *Pre-start* or *Demand Received* indications. This could be displayed either in the driver's cab or at a suitable location on or near the relevant signal.

8.55. Primary LRT signals should normally be located on the left-hand side of the track. They may be located on the right-hand side of on-street tramways (i.e. between pairs of tracks), subject to the clearance requirements being met.

Tramway and Highway Traffic Signs

8.56. The need for signage and highway markings is linked intrinsically with the need for suitable training to provide tram drivers with appropriate route knowledge, and the need for the signs and highway markings to remind drivers of safety related issues that they should already be conversant.

8.57. Signs for other highway users following the introduction of a tramway are prescribed in the TSRGD. Signs that are not prescribed in these regulations should be specifically authorised by the DfT. Further information on signage is given in the TSM and in LRG 4.0 Signing and Marking of Tramways Guidance.

8.58. All signs shall be prescribed signs that can be legally placed on the highway. Only prescribed signs can be legally enforced, for example, in relation to obstructions of the tramway and trespass.

Therefore, any use of non-prescribed signs is not only unlawful, but of little practical use and could expose the tramway operator to legal proceedings.

8.59. A proliferation of signs should be avoided. For example, where generic speed restrictions are applied at specific locations like through tramstops, application of operational procedures may be more appropriate than individual signs for each restriction.

8.60. Signs applicable to only tram drivers should be mounted so as to be conspicuous to drivers of trams but presenting as little distraction to other highway users as possible, for example on electric traction poles. Details of these signs and further information is provided in LRG 4.0 Signing and Marking of Tramways Guidance.

8.61. Off highway there is no requirement to use prescribed highway signage. However, it is strongly advised that signs for tram drivers follow the prescribed signs in order to provide consistency with the on-street sections of the tramway as well as simplicity and driver familiarity with prescribed signage.

Speed Limits

8.62. Prescribed retro-reflective lineside signs indicating the maximum permitted speed as shown in Diagram 976 in the TSRGD should be provided throughout a tramway. All signs should be similarly mounted and located at the tram driver's eye level. These signs would normally be fitted in the following circumstances:

- The maximum permitted speed on a section of tramway changes; or
- The maximum permitted speed of a tramway located in the carriageway differs from the limit for other highway vehicles.

8.63. In certain situations, generic speed restrictions would normally be applied at specific locations where it may be more appropriate to apply of operational procedures, rather than signs for each restriction, for example, through tramstops.

8.64. Speed boards should be located in a position at which the driver can accelerate or decelerate to the plated speed taking into consideration all credible lengths of trams or consists of trams such that the rear bogie is not in an area where is not safe to accelerate to the higher speed.

8.65. The maximum permitted speed of a tram on a carriageway shared with other highway traffic should be approximately the same as, or lower than that for other highway traffic.

8.66. The maximum permitted speed of a tram on a segregated on-street section may be higher than that for other highway traffic provided that the presence of the tramway is clearly indicated to other highway users. Any higher speed should be agreed with the police and the Highway Authority. An Order under Section 84 of the RTA may be required.

Control of LRT Signals

8.67. Where LRT signals are associated with ordinary highway traffic signals on on-street tramways, they should be controlled by the local road traffic signal controller interfacing with the tramway signalling system.

8.68. Whatever additional tramway controls are superimposed upon the local highway traffic signal controller, the traffic system should be able to function independently and process tram demands if the transmission link to a central controller fails.

8.69. The local road traffic signal controller should not be involved with determining route information for the tram, but should be presented with the appropriate demand being received from the tram detection equipment.

8.70. In certain circumstances, it may be necessary for an interface unit to be interposed between the road traffic signal controller and the tram detection equipment. This arrangement should also be able to function on its own if the link to any tramway supervisory or control system fails. The fundamental system may be developed further to encompass higher order traffic control systems.

8.71. Wherever the control of the LRT signals is through a normal road traffic signal controller, the detection of the lie of the points on a running line should be shown through a separate point indicator.

8.72. The design of the control system should be such that intersections can be safely controlled, allowing such precedence for trams as may be agreed with the Highway Authority, as described in Appendix A.

8.73. In fixed-time systems, the tram phases should run irrespective of the presence of a tram. For demand-dependent systems, LRT signal phases should run in conjunction with parallel and complementary phases for other highway users.

8.74. Where the traffic control system for a particular junction goes into failure mode due to a fault, an external demand may be made from the OCC for the tramway.

8.75. Where tram movements conflict with other highway traffic flows, separate stages or phases should be provided solely for tram movements. *Proceed* aspects for trams should not return to *Stop* before any parallel *Proceed* signal for other highway vehicles. An allowance should be made to give the tram earlier warning of the impending *Stop*, and so reduce the risk of the tram overrunning the *Stop* line and a longer all-red period (i.e. the inter-green period) may be required following the termination of the tram phase. Taking into account the tram signal cluster aspect.

8.76. The design of a pedestrian crossing should ensure that, subject to a timeout in the event of an undue delay, the *Proceed* aspect for pedestrians (and the *Stop* aspect for a tram) cannot be given if an approaching tram is within its service braking distance of the crossing.

Tramway Control Room

8.77. The tramway operations control and electrical control should normally be combined.

8.78. The design of the tramway control room should provide a working environment that minimises distraction and fatigue, to avoid the risk of error by the staff responsible for the control of operations.

8.79. A human factors study should be carried out at the design stage or when there is a significant change to the control room or systems. It should form part of a wider change control procedure.

For further information refer to LRG 29.0 Guidance for Human Factors in Operations Control Centres.

8.80. The integrity of controls and indications should be appropriate to the extent to which safety depends upon their correct operation. Both normal operating and degraded operating conditions should be taken into consideration when assessing the risks and the level of integrity required.

8.81. A degree of independent functionality between the systems is desirable.

8.82. The control room equipment essential for the safe operation should be protected from the consequences of electrical supply failure at the control room. Any loss of power or changeover to battery supplies should not cause a loss of integrity in the ability to control the system.

8.83. All information necessary to control the system safely should be continuously displayed. Display screens capable of showing the track layout and positions of tramstops should be provided. Display screens for the electrical supply systems should be provided that are capable of showing the locations of feeding points, and the actual position and status of circuit-breakers and section isolators and the automatic status of the OLE i.e., whether it is live or dead.

8.84. If any diagram or diagrams respond to the position of trams, the lie of points or switches, position of circuit breakers or aspect of LRT signals, such information should be clearly displayed.

8.85. Switching between displays in the course of an operation is not acceptable if this gives rise to a consequent need to remember the status of relevant items.

8.86. A fixed line diagram or diagrams should also be provided to enable operations to continue in the event that the display screen equipment is unavailable.

8.87. There should be a high integrity recordable communications system for use between the local emergency services control room(s) and the tramway control room. Tramway control room staff should be made aware of any incoming calls on such a line, even if other communications systems share the same equipment. A similar line should be provided to the controlling railway control centre that crosses or shares an alignment with the tramway. All such communication lines should continue to function if mains power is lost at the tramway control room.

8.88. Whenever control-room staff pass messages that are critical to safe operation, all messages shall be recorded, and the recordings retained. Where safety is dependent on communications between control-room staff, these communications should be similarly recorded / documented.

8.89. LRG 30.0 Depot Control Centre Guidance contains further information.

Communication Systems

8.90. A system of communication between the tramway operational control room and trams shall be provided. The system proposed should provide comprehensive coverage of the network, and prior to its operation, tests should be conducted to validate its coverage.

8.91. A system allowing selective calling and identification of individual trams, or groups of trams should be provided. The system should incorporate the facility for each of the emergency services and

tramway personnel to use their own portable devices within their own command structure. Any such facility should be functional throughout any running tunnels and within any access shafts and cross passages.

8.92. Voice communications between control and the tram driver should be kept separate from those between the tram driver and the passengers so as to prevent the latter from overhearing control messages.

8.93. For further details refer to LRG 31.0 Network Supervision Management Guidance.

9. Tram Design and Construction

9.1. This Section provides information on the design of trams and the construction of tramways. For information in relation to noise and vibration aspects, refer to LRG 38.0 Noise and Vibration Guidance.

General Guidance

9.2. A tram should be designed so that it is safe for its users (passengers as well as members of staff) and does not endanger all other users of the highway as well those in the immediate vicinity of off-street sections.

9.3. Although trams are not subject to the mandatory requirements for highway vehicles, they should nevertheless include features in their construction and performance that make them safe for use on the highway and in other places where they share the infrastructure with other users.

9.4. Although not required by legislation, a tram that operates on-street should generally conform to the current Road Vehicles (Construction and Use) Regulations 1986 as this would be considered as good practice for a highway vehicle. These regulations cover all aspects of highway vehicles including weights, dimensions, safety items and environmental standards and are updated progressively by the UK Government alongside updates to any rules on vehicle safety or operation.

9.5. Much of this regulation derives from directives of the EU, and these in turn derive largely from United Nations Economic Commission for Europe (UNECE) Regulations and are globally agreed standards.

9.6. The website of the UK Vehicle Certification Agency (VCA) has a list that shows which of these UNECE Regulations have been translated into EU directives and which in turn are to be implemented in the UK through amendments to the Construction and Use Regulations. The UK withdrawal from the EU has not affected the content or locus of the UK regulations.

9.7. The VCA website[47] also has useful summary diagrams for buses and goods vehicles that show which directives / regulations apply to which aspects of those highway vehicles.

9.8. The section below is in line with the above regulations.

Compatibility

9.9. A tram to be used on the highway should be equipped with a system of communication to permit it to be detected by road traffic signal controllers so that the appropriate stage and phase can be called on the road traffic signals.

9.10. The system should also be able to request a specific route at junctions and actuate the safe operation of the points.

47 VCA website: https://www.vehicle-certification-agency.gov.uk/

External Lighting

9.11. The external lighting of trams which run on-street should conform so far as practicable with the Road Vehicle Lighting Regulations 1989 (as amended)[48] to achieve the following objectives:

- In the forward direction, it should uniquely identify the vehicle as a tram;
- Bi-directional trams should carry the full range of lights and reflectors for running in either direction; and
- Lights and reflectors on the sides of the tram should be similar to those required for large goods vehicles rather than those for PCVs (refer to the Road Vehicle Lighting Regulations 1989).

9.12. The arrangements shown in Table 9.1 below as provided in the above regulations are considered to meet the above objectives.

Table 9.1: External Lighting

	Facing Forward	Facing Rearward	Along the Sides
Headlights	Two white dippable and a third white dipped mounted centrally above them	-	-
Position Lights	Two white	Two red	-
Outline Marker Lights	Two white	Two red	-
Side Marker Lights	-	-	At least three for a 30 m long tr–m - amber
Direction Indicators	Two amber	Two amber	Amber (combined with side marker lights)
Reflectors	Two amber (may be combined with direction indicators)	Two amber (may be combined with direction indicators)	At least three for a 30 m long tr–m - 1 m above highway lev–l - amber
Brake Lights	-	Two or two clusters - red	-
Fog Lights	-	Two high-intensity - red	-
Hazard Lights	Two amber	Two amber	Flashing amber side markers

48 Road Vehicle Lighting Regulations 1989: https://www.legislation.gov.uk/uksi/1989/1796/contents

9.13. As an alternative to a third centrally-mounted high-level white light (the 'cyclops'), a suitably large and well illuminated destination indicator may be able to perform the same function, as long as it is always lit.

9.14. Further relevant regulations include the following:

- Community Directive 76 / 756/EEC49 addresses overall road vehicle lighting installations and is implemented in the UK through the Vehicle Lighting Regulations 1989 (as amended);
- UNECE Regulation 113[50] defines dimensions, colour of light output and luminous intensity; and
- UNECE Regulation 48[51] defines positioning, alignment and visibility.

Lamp Positions

9.15. Lamps should be positioned as close as practicable to the positions prescribed within the Road Vehicle Lighting Regulations 1989 (as amended).

9.16. Due allowance should be made for the construction and shape of the ends of the tram in permitting variations from the specified heights and distances from the sides.

9.17. Whilst exempt from the requirements of the Construction and Use Regulations, trams should be designed to follow, as far as possible, the requirements placed on PCV and goods vehicles. This provides consistency of visibility for other highway users.

9.18. Given the above, the following guidelines are generally considered to offer a suitable arrangement:

- All the lamps, except the centrally-mounted headlight and the side-mounted lights, should be placed as close as possible to the side of the tram, preferably at a distance of not greater than 400 mm;
- Front and rear position lamps and direction indicators should be approximately 1500 mm from the ground;
- The end outline marker lamps should not be below the top of the windscreen at either end; and
- The main pair of headlamps should be placed between 500 mm and 1200 mm from ground level and the central headlamp, above the windscreen.

9.19. In addition, trams running on-street should feature the following:

- All the headlamps, the position lights, end outline lamps and the side marker lights should be lit. The other lamps should be lit as the occasion demands;

49 76/756/EEC: The approximation of the laws of the Member States relating to the installation of lighting and light-signalling devices on motor vehicles and their trailers

50 UNECE Regulation 113: Uniform provisions concerning the approval of motor vehicle headlamps emitting a symmetrical passing beam or a driving beam or both and equipped with filament, gas-discharge light sources or LED modules

51 UNECE Regulation 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices.

- All the white lamps and none of the red lamps should show forward in the direction of travel and vice versa to the rear;
- The front, rear and side direction indicators should all flash together. If combined side marker lights and side direction indicators are provided, the indicators should be substantially brighter than the marker lights;
- The normal road vehicle configuration for hazard warning lights should apply; and
- For safety purposes, it should be possible to leave the hazard warning lights on with the driver's key removed.

9.20. The following lamps should be provided:

- Three headlamps, front position lights and rear position lights;
- Brake lights; and
- Higher-intensity rear fog lamps (which may be used in place of the rear position light, but care should be taken not to override the visibility of the brake lights).

9.21. The side marker lamps required for other sections of tramway do not need to be lit on the off-street sections. It is not necessary for the direction indicators to operate on off-street sections unless required to do so by the operating requirements of the system.

9.22. Where different arrangements apply for on-street and off-street sections of a tramway system, a single selector switch should be provided in each driver's cab to change the configuration of the lights when changing from one type to the other.

9.23. The light output of the various lamps and size of reflectors should conform as near as practicable to those specified in the Road Vehicle Lighting Regulations 1989 (as amended). The following points relating to these regulations should be noted.

- Care should be taken not to oversize the side marker lamps;
- External 'door open' lights may be provided, but these should be designed so as to give no confusion with the lights required to be shown when the tram is in motion; and
- A tram should not display a red light or reflector at the front.

9.24. The regulations provide for the use of LED light sources instead of filament lamp sources.

9.25. In the event of failure or loss of the low voltage supplies from the auxiliary converter or generator (as appropriate to electric or diesel-powered trams), the tram's on board batteries should be capable of maintaining the external lighting including the dipped beam headlamps. This should allow sufficient time for the tram to be driven to a place where it can safely be removed from service if appropriate, or to allow time for it to be recovered by another vehicle. Details are provided in BS EN 13272-2:2019[52] and EN 45545-1:2013[53].

9.26. The adequacy of light output should take account of the environments within which the tram will operate, for example, if running on unlit reserved sections of tramway.

52 BS EN 13272-2:2019: Railway applications - Electrical lighting for rolling stock in public transport systems - Part 2: Urban rail

53 EN 45545-1:2013: Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behaviour of materials and components

Driving Mirrors and Rear-View CCTV

9.27. Except when trams run solely off-street, mirrors, CCTV or other devices shall be provided to give the tram driver a rearward facing view along both body sides when the tram is in motion. Such mirrors or devices should be included within the SE.

9.28. Any rear view mirrors, CCTV or other devices should be in good working order prior to a tram entering or remaining in service.

9.29. At tramstops, the tram driver should be able to clearly observe passengers boarding and alighting, to confirm no passenger has been trapped by a closed door and all pedestrians are adequately clear of the tram before it starts.

9.30. Whilst setting off and in motion, the tram driver should be able to observe traffic on either side of the tram, particularly in regard to under or over-taking vehicles. This is especially the case when ahead of commencing a turn off the main carriageway or when joining the carriageway.

9.31. The images presented to the driver should not be unduly affected by darkness, low angled sun, or prevailing weather conditions for example rain in dark conditions.

9.32. Consideration should also be given to providing drivers with visibility of any external parts of the tram which may be susceptible to surfing activity, for example, the rear end of the vehicle and the space between coupled vehicles.

9.33. Where either CCTV or mirrors are used for rear viewing then consideration should be given to the ergonomic issues that arise in the driver's cab layout. The CCTV displays or mirrors should be placed so that they are easily visible to the driver from their normal position, without the need to unduly divert his attention from the highway ahead. (Refer to LRG 17.0 Driver Inattention Systems Guidance for further information on driver inattention systems).

9.34. There should be no significant loss of view alongside the tram between what can be seen directly from the driver's cab and through CCTV / mirror i.e. no blind spot.

9.35. From within the driver's cab the driver should be able to adjust the position or angle of any rear view mirrors, or the image quality of any CCTV displays.

9.36. The height of the mirrors or CCTV cameras relative to pedestrians, and in particular those standing on tramstop platforms, should be considered carefully so as to obtain the best compromise between visibility to the tram driver and the risks of pedestrians standing close to the platform edge being struck by them.

9.37. For CCTV systems, some further guidance may be derived from UNECE Regulation 46[54].

9.38. Where CCTV is provided, the images should be recorded.

54 UNECE Regulation 46 Devices for indirect vision and motor vehicles with regard to the installation of these devices

Audible Warnings

9.39. Trams should be fitted with an audible warning device at both ends of the vehicle. The warning emitted should be in keeping with the environment in which the tram runs.

9.40. The warning should be loud enough to indicate the approach of a tram without causing injury or undue alarm to those in the proximity. Audible levels for warning devices should meet the recommendations in BS EN 15153-4:2020[55]. Information on the testing of audible warning devices is provided in LRG 5.0 Tramway Audible Warning Acoustic Test Guidance.

9.41. Where trams run on-street and off-street the warning device should have two levels of sound as they have different needs and applications as prescribed in LRG 5.0 Tramway Audible Warning Acoustic Test Guidance.

9.42. For on-street sections of the system there should be a lesser level of sound to alert people of the tram's presence. The sound produced should be distinctive compared with that emitted by other road vehicles.

9.43. The greater sound level is for use in the event of an emergency when on-street and when the tram is off-street.

9.44. The warning device for use on-street might be provided by using a single stroke gong which can be rung at different rates depending upon how rapidly the operating pedal or button is depressed.

9.45. A horn similar to those on buses or cars would be considered suitable.

9.46. It is desirable for warning horns to provide a spectrum which is rich in harmonics, to optimise audibility for people with partial hearing loss.

Pedestrian Protection and Obstacle Deflection

9.47. The following collision protection should be provided for pedestrians:

- Both the tram ends and sides should be continuously skirted. The bodywork and skirting should be designed to deflect people who may come into contact with the tram and stop them from passing beneath;
- There should be a lifeguard fixed to the tram providing underrun protection in front of the leading wheels designed to prevent people or objects being run over by the tram, with adequate clear survival space to prevent crush injuries. This is in addition to any wheel guard provided in front of the wheels for the purpose of obstacle deflection; and
- The lifeguard should be positioned as close to the highway surface and to the wheels as is reasonably practicable. It may have a deflecting lower edge of pliable material to close the gap to the surface of the highway.

9.48. Effective obstacle deflection equipment should be provided to reduce the risk of derailment. This equipment may be attached to the running gear or to the tram underframe. Such protection is in

55 BS EN 15153-4:2020 Railway applications - External visible and audible warning devices - Part 4: Audible warning devices for urban rail

addition to that provided in relation to pedestrian collision although the same equipment can serve both purposes.

9.49. The outside of the trams should be designed to deflect pedestrians away from the path of the tram wherever possible.

9.50. Consideration should be given to installing systems that provide additional warnings to the driver of potential hazards within the forward path of the tram, for example, camera based obstacle detection and / or Driver Assistance Systems (DAS).

Structural Integrity

9.51. As a minimum, the underframe and body, including any articulation joint, should be designed to provide the following:

- Have sufficient mechanical strength to withstand the anticipated loads in normal operating conditions;
- Mitigate against the known effects of a collision with another tram, highway vehicle or buffer stops in a way which minimises injury to passengers, staff and other highway users; and
- Have adequate jacking points, with their positions clearly identified on the outside of the tram and accessible for use by the emergency services.

9.52. Reference should be made to BS EN 12663-1:2010+A2 2023[56] classes P-iv or P-v as appropriate and also BS EN 15227:2020[57] in regard to crashworthiness. Class P-v may be considered generally appropriate for tramway operations using (normally) single trams under line of sight operation at speeds up to 80 km/h. Class P-iv may be considered more appropriate for operations at speeds greater than 80 km/h and / or where a substantial proportion of operation is undertaken under fully signalled conditions on fully segregated alignments. Note that tram-train requirements may differ.

9.53. Consideration should also be given, where possible, to mitigating the effects of body side collisions from other highway vehicles.

Windows and Glazing

Windscreens

9.54. Windscreens and other forward-facing windows should be able to resist impact from projectiles or other objects falling onto the tram.

Saloon and Door Windows

9.55. Tram windows should as a minimum conform to current UNECE standards for passenger carrying vehicles on the highway. A risk assessment based upon the operational conditions and available technology should be conducted to determine if higher standards of glazing are required.

56 BS EN 12663-1:2010+A2:2023 Railway applications. Structural requirements of railway vehicle bodies. Locomotives and passenger rolling stock (and alternative method for freight wagons)

57 BS EN 15227:2020: Railway applications. Crashworthiness requirements for railway vehicle bodies

9.56. It should not be possible or necessary for people to lean out of windows.

Couplers

9.57. Couplers and drawgear may be one of the following two types:

- For regular service use if the operation of the tram system demands it; or
- For emergency use only in all other cases.

9.58. Any coupler fitted to a tram operating on an on-street tramway should be designed to fold away or otherwise be retracted when not in use. The extended position of the coupler should be included within the SE.

9.59. On trams fitted with couplers, adequate fenders or protective covers are required to mitigate damage to other highway vehicles in the event of an accident. The end of any folded or retracted coupler should be within the bodywork. Any sharp edges or points should be covered and provided with suitable fenders.

9.60. The use of fixed couplers is not recommended.

9.61. Couplers should be designed to sufficiently withstand the loads for which they are in place for operational need. Intended loads should consider also any instantaneous 'snatch' loads that might occur when a rescue tram has to pull away with a failed tram.

9.62. Service loads might also have to consider situations where trams being rescued have some brakes still applied.

9.63. The coupler should be designed to accept at least the load imposed when hauling or propelling a failed tram anywhere on the system, i.e. the highest gradient, tightest curve etc.

9.64. Special consideration should be given to the potential of failure of the coupler during recovery of an unbraked tram and subsequent mitigation to prevent uncontrolled movement or run-away.

Driver's Cab

9.65. The driver's cab should be designed on ergonomic principles. All the controls and indications needed while driving should be convenient to use for the driver's wellbeing and to assist any quick reactions, and also located so as to minimise the risk of error.

9.66. The interior layout of the driver's cab should be designed to prevent portable objects being placed where they would obscure the tram driver's visibility or interfere with the controls. This includes adequate stowage provided for the driver's personal effects, and a convenient location for any timetables, documentation or notices to which drivers may need to refer frequently.

9.67. The design of the driver's cab should offer optimum internal and external visibility for the driver. Refer to BS EN 16186-8:2022[58] for further guidance.

58 BS EN 16186-8:2022 Railway applications. Driver's cab - Part 8: Tram vehicle layout and access

9.68. Consideration should be given to the driver's access to and egress from the cab. If the driver's cab does not have an external door, an external saloon door located immediately behind the driver's cab should be provided. Such a saloon door should be provided with separate internal and external controls for the use of staff.

9.69. Any door between the driver's cab and the passenger saloon should be either sliding or open into the driver's cab in order to avoid the problems of blockage by passengers and / or their baggage.

9.70. Where access and egress is only possible via the passenger saloon, a removable or breakable driver's cab side window should be fitted for emergency egress.

9.71. Consideration should also be given to which driver's cab side window is to be breakable in emergency. If the driver's saloon exit door is to the right, then the breakable window should be on the left side. This will maintain at least one exit in the event of overturning.

9.72. LRT signals, signs, passengers waiting at tramstops and other highway traffic should be clearly visible from the driver's cab under all credible operating conditions.

9.73. Suitable means of obscuring the sun and for preventing distraction as a result of reflected light from driver's cab instruments or saloon lighting should be provided.

9.74. An internal mirror or other devices may be provided to enable the tram driver to observe passengers within the tram saloon.

9.75. The driver's cab should afford sufficient heating, cooling and ventilation to allow the driver to remain comfortable under all credible operating conditions and not impede driving of the vehicle, including the driver being able to control the temperature. Where the driver will be required to change ends, the system should ensure that both of the driver's cabs offer the same comfort level.

9.76. On double-ended trams, where the driver will be required to change ends, the driver's cab ventilation and / or heating systems should be capable of being left operational in the unoccupied driver's cab and / or a system that automatically sets both cabs to the same levels to ensure a suitable working environment is maintained for the next time that the driver needs to change ends.

9.77. Provision should be made for a trainers seat fixed or otherwise with physical or remote access to the emergency brake button.

Driving Controls and Indications

9.78. The driving controls and indications available to the tram driver should enable the tram to be operated safely whether in normal operating conditions or in emergency situations. The controls for any signalling system and / or displays of them should not detract from this or impair it.

9.79. The driver's controls should be laid out with consideration for ergonomic issues and to minimise the risk of incorrect operation. It is suggested that a human-factors study is undertaken at the design stage to verify this. DIN 5566-3+A1:2023-12[59] may be of assistance for ergonomic matters.

9.80. It should be possible to easily recognise and / or read the displays on the driver'' desk under all credible lighting conditions. Brightness of illuminated displays should be capable of adjustment by the driver.

9.81. Recognised highway vehicle symbols / icons should where appropriate be used for controls, indications and icons.

9.82. Illuminated displays and controls should be positioned such that they are not reflected in the windscreen or driver's cab side windows such that the driver's ability to see ahead and to either side would be impaired.

9.83. Consideration should be given to the position of the driver. The driver should normally be located in the centre of the driver's cab or to the right of centre. The seat should have sufficient adjustment such that the tram driver can observe the nearside footway.

9.84. The features in the following paragraphs should be provided within the vehicle.

Traction Brake Controller (TBC)

9.85. It is recommended that the convention of *Forward* for Power and *Backwards* for Stop is used for UK tramway systems.

9.86. Movement of the Traction Brake Controller (TBC) handle in the backward direction should result in a gradual increase in the braking effort, with full service braking reached at a gate position beyond which point results in an Emergency 3 (hazard brake) application being made. Moving the handle forward from Emergency 3 should revoke this hazard braking mode.

Driver Assistance Devices

9.87. Driver Safety Device (DSD)[60] – This function is intended to stop the vehicle if the system detects that the driver is incapacitated whilst the vehicle is in motion. This function is normally achieved by requiring the driver to activate a switch confirming their presence. Release or non-contact with this switch triggers this function. (Colloquially referred to as the 'Dead-Man's Function.)

9.88. Driver Vigilance Device (DVD) – A dynamic system that monitors tasks being performed by the driver whilst the vehicle is in motion. Lack of detected activity results in an alert. If further activity is not detected following an alert, then an intervention is triggered. Refer to LRG 17.0 Driver Inattention Systems Guidance for further information.

59 DIN 5566-3+A1:2023-12 Railway vehicles - Driver cabs - Part 3: Additional requirements for urban and suburban rolling stock

60 The current BS EN 13452:2003 – Railway applications – Braking – Mass transit brake systems is aligned to mass transit systems and as such, does not accord with UK tramway terminology. For instance, this standard recommends that instead of the term 'Driver Safety Device' the term 'Driver Vigilance Device' is used.

9.89. Speed Management Systems are intended to reduce the likelihood of a serious accident being incurred as a result of a vehicle overturn or derailment owing to excessive speed. Refer to LRG 18.0 Speed Management Systems Guidance for further information.

An Emergency Brake Button

9.90. This is in addition to a traction and brake controller (as above).

9.91. Provision should be made for a trainers seat fixed or otherwise with physical or remote access to the emergency brake button.

Emergency 'Pantograph Down' Button for Pantograph Systems (or Equivalent Button)

9.92. The pantograph down button (or its equivalent) should be of a distinctively different colour to any control provided for the emergency brake.

9.93. Once operated, release of this button should not allow the pantograph(s) to be raised until the normal pantograph raise / lower control has been operated.

9.94. The button controls for the emergency brake and emergency 'pantograph down' (as above) should be different in shape to other button controls and should be mushroom-shaped. They should also be distinctively coloured.

9.95. The emergency brake button should be red.

A Speedometer

9.96. This should be calibrated in kmp/h and should be both analogue and digital.

A Data Recorder

9.97. This should have sufficient channels and capacity to record information pertinent to the investigation of accidents involving the tram and capable of being calibrated, downloaded and presented as evidence. This should include the following as a minimum:

- Tram identification number;
- Distance;
- Speed;
- Time / date;
- Traction brake controller;
- Sander activation;
- Horn operation;
- All braking activities including emergency brake activation;
- Door activations;
- Traction power; and
- Switches to operate the main tram traction power supply circuit-breakers means to disable the controls at non-active driving positions.

9.98. Other optional inputs should be considered by the operator, for example, head light operation, trafficators, etc.

9.99. This is to prevent interference with them whether accidently by the driver or another crew member, or by any unauthorised person (for example, a member of the public).

9.100. In addition to all of the above, if a reverse function is provided, it should not be possible to be selected without requiring it to be a conscious action on the part of the driver. This can generally be achieved by requiring the driver to use both hands, for example, by the need to depress a push-button at the same time as turning the selector switch to the Reverse position.

9.101. Systems, controls and indications should also be considered to have the following functions:

- Protect against wheel slip when accelerating or wheel slide when braking;
- Operate sanding gear; and
- Control the functions of the internal and external communication equipment to prevent mutual interference and cross-talk.

9.102. In addition, when reasonably practicable they should be considered to have:

- Systems to limit the speed generally for on-street sections of the tramway alignment such as small radii curves; and
- Systems to provide additional warnings to the driver of hazards in front, rear or in between tram in the case of coupled trams using, for example, cameras and / or radar.

Design of Passenger Saloon

9.103. The interior layout and fittings of trams should be designed to minimise injuries to passengers and tram crew when in normal operating conditions as well as in the case of an emergency situation.

9.104. The ratio of seating to standing passengers is a matter for the operator. However, for planning purposes the density of standing passengers should not normally exceed four passengers/m^2 of available standing space.

9.105. Gross laden weight calculations and floor strength requirements should be based on a standing passenger density of 8 passengers/m^2 of available standing space.

9.106. Any internal steps shall meet the requirements of the RVAR.

9.107. Interior lighting in trams should meet the lighting levels provided in other passenger carrying vehicles. In common with these vehicles, additional lighting in doorways, steps and internal stairways should be considered

9.108. Lighting should be maintained in the event of electric traction power being lost. Emergency lighting should be provided to automatically illuminate upon loss of traction power and battery power. Lower lighting levels are acceptable, they should be sufficient to enable the tram to be evacuated safely. Refer to BS EN 13272[61] for further information.

61 BS EN 13272 Railway applications. Electrical lighting for rolling stock in public transport systems

9.109. Also refer to LRG 8.0 Guidance in the Management of Vulnerable Persons.

Interior Fittings

9.110. Interior fittings of trams should be designed so as not to cause injury in normal operating conditions and to minimise secondary injuries to passengers should the tram be involved in an accident. Interior fittings should include the following:

- Compliant grab-rails and poles shall be provided;
- Compliantly sized grab-rails and poles for mobility-impaired passengers and for standing passengers;
- Coloured compliant grab-rails and poles easily seen by the visually impaired;
- Hanging straps, if fitted, should have limited movement and be secure under load;
- Interior glass partitions which conforms to current passenger carrying vehicle standards and has protected exposed edges;
- Passenger-operated buttons (door opening, alarm, stopping request);
- Internal passenger information display screens; and
- Detachable seat cushions.

9.111. Facilities shall be provided for mobility-impaired passengers in accordance with the RVAR. Also refer to LRG 8.0 Guidance in the Management of Vulnerable Persons

Emergency Equipment

9.112. Equipment for emergency use should be carried on each tram. Suitable provision should be made for stowing emergency equipment so as to be reasonably accessible to the tram driver. The following should be carried / accommodated where required:

- Fire extinguisher;
- First aid kit;
- Ladder;
- Detrain board ramp; and
- Track circuit clips (if adjacent to Network Rail infrastructure).

9.113. Refer to LRG 20.0 Fire and Rescue Guidance for further information.

Access and Egress

<u>Doors and Controls</u>

9.114. Tram doors should be designed to operate safely in all operating conditions.

9.115. BS EN 14752:2019+A1:2020[62] gives some guidance on the design of passenger doors and doorways. The requirements of the RVAR shall be met where relevant.

62 BS EN 14752:2019+A1:2020: Railway applications. Body entrance systems

9.116. Doors and associated areas should be designed to minimise the danger of any trapping injury. They should be fitted with obstacle detection equipment and should not operate with excessive force. It should be possible to release limbs or other objects trapped by the doors without difficulty.

9.117. Where fitted, folding steps or sliding plates should be interlocked with the electric traction power controller and brakes to prevent movement of the tram when they are deployed.

9.118. When the tram is moving, external passenger doors should be secured in the closed position. It should not be possible for the tram to start unless all external passenger doors are closed and secured. In the event of doors or their control system moving from the *Closed* position while the tram is moving, traction power should be removed automatically, and the brakes should be applied. Passenger doors should have the facility to be individually isolated in the closed position owing to failure or damage.

9.119. Passenger door controls and the method of operation should be clearly and unambiguously signed to the user.

9.120. The door arrangements should enable passengers and tram crew to evacuate safely. It should be possible for passengers to open external doors once the tram is stationary. Emergency door releases should be operable to allow the opening of external and internal doors even if there is a failure of any tram equipment including the power supply.

Door Controls

9.121. If passenger-operated door control buttons are provided, they:

- Shall be compliant with the RVAR; and
- Should only be enabled when the tram is correctly located at a tramstop and / or it is safe to disembark or in the case of an emergency evacuation.

9.122. Emergency opening devices fitted inside the tram should be able to be used by the passengers without the help of the tram driver. When these devices are operated, this should be brought to the attention of the driver. It should not be possible to open the doors until the tram is at / nearly at a standstill.

9.123. There should be a means of releasing designated external doors from the outside in an emergency.

9.124. The design and labelling of internal and external door emergency releases should deter non-emergency use. Bylaws may be used to display penalties for improper use.

9.125. The tram driver should be able to easily identify which emergency door-opening device has been operated. After operation, the device should be able to be cancelled only by the driver or other members of the tramway staff.

9.126. If the external emergency release device is also intended to be used as a means of opening tram crew access doors, it should be possible to reset it from both inside and outside the tram.

Communications

9.127. Alarm points conforming to the RVAR should be provided so that in an emergency, it is possible for passengers to communicate to the tram crew, and for the crew (or where required the tramway system controller) to communicate to the passengers. Special consideration should be given to the position of call points in the designated wheel chair area.

9.128. Where there are request stops, facilities for requesting the tram to stop should be provided. The use of this facility should be clearly indicated both in the driver's cab and in a prominent position in the passenger compartment and accompanied by audio announcements both in the vehicle and at the tramstop. Such equipment shall comply with the RVAR.

Electrical and Power Supply Systems

9.129. The electrical and other power supply systems and equipment on trams should not endanger other systems or people in either normal operating conditions, maintenance, emergency or failure modes. Consideration should be given to the location of equipment that the tram driver may need to access for resetting, in order to ensure that it is easily accessible for the tram driver, but not exposing them or passengers to potential risk.

9.130. Safety critical systems should be designed to fail to a safe mode, either by redundancy or before safety critical levels are reached. Suitable alarms or interventions should be provided as necessary and located in an appropriate position.

9.131. Preventative measures should be provided to guard against fire as a result of power supply or electrical system overload under fault conditions.

9.132. In the event of power failure, preventative measures should also be in place to enable a tram to be either operated safely under emergency situations, or to be recovered / removed from causing an obstruction on the highway.

9.133. A battery should be installed so in the event of failure of the electric traction power supply, it can provide sufficient interior and exterior lighting (as appropriate to the tram system) and other essential subsystems. The battery and control system should be independently capable of supporting the electrical load as specified within EN BS EN 13272-2:2019 Table 2 'Minimum operating times for emergency lighting according to operation categories, as defined in EN 45545-2:2020+A1:2023[63], 5.2.1'.

9.134. Consideration should be given to the provision of a mechanism to charge the battery from an external source if flat owing to prolonged discharge via a battery charging socket / terminals to enable pantograph to be raised once the battery has been charged sufficiently. This should be accessible from the ground (i.e. not on the roof).

9.135. The power supply system on board the tram should provide an adequate, protected path for the return current, and should be protected against the effects of accidents, power system failure and unauthorised access to the live parts.

63 BS EN 45545-2:2020+A1:2023 Railway applications. Fire protection on railway vehicles. Requirements for fire behaviour of materials and components

9.136. The power systems should be appropriately guarded against unauthorised access.

Electric Traction Power Supply

9.137. The design and construction of the collector for the electric traction power supply and associated isolators and protective devices should consider the need to avoid hazards, either to tram operating staff or to the public.

9.138. Of particular consideration is the pantograph; BS EN 50206-2:2010[64] gives additional guidance on pantographs for tramway use.

9.139. Over current protection and isolation arrangements should be provided as close to the source as possible. The main traction power circuit breakers and line fuses should be roof-mounted for overhead electric traction systems.

9.140. Overhead systems should be fitted with roof-mounted lightning surge arrestors.

9.141. Sufficient and effective bonded paths to the tyres of the wheels from the superstructure should be provided on any tram used on an electric tramway system or on an alignment shared with an electric railway. The return path, if this is through the rails, should be designed to ensure that conductivity remains sufficient through the wheels at all times.

Isolating Devices

9.142. The following means of isolating the tram from the traction supply should be provided:

- Control by which the tram driver may isolate the power supply between the current collector(s) and the electrical equipment without leaving the cab;
- Control by which the tram driver may disengage the current collector(s) from the source without leaving the cab; and
- Control by which the current collector(s) may be disengaged from the traction supply which is accessible from ground level outside the tram; its position should be clearly marked.

9.143. In the case of trams powered or assisted by a battery or other on board energy sources, equivalent provisions to the same standard as required by the PCV Regulations should be provided, to allow the energy source(s) to be shut down by the tram driver from within the tram. A similar facility should be provided on the exterior of the tram that is accessible from ground level and its position(s) should be clearly marked.

9.144. Once operated, it should not be possible to reinstate the functionality of the tram's control systems simply by resetting isolation switches. Returning the tram to operational status should only be possible once the tram has been shut down and re-initialised using the normal driver's cab controls.

64 EN 50206-2:2010: Railway applications. Rolling stock. Pantographs: characteristics and tests. Pantographs for metros and light rail vehicles

9.145. A means of isolating any traction battery should be provided, which is accessible from ground level outside the tram. Its position should be clearly marked.

9.146. Other electrical circuits should also be protected by isolating switches and circuit breakers, which may be combined as appropriate.

9.147. Where there is a means of isolating the battery or other sources of stored energy, the operation of this facility should not result in the immediate loss of communication between the tram driver and the system controller, nor any loss of emergency lighting. Communication requirements may be met by providing the on board communication equipment with a local back up battery with sufficient capacity to ensure that the tram driver is able to adequately communicate in an emergency, or to ensure that the tram driver has access to a separate independently powered means of communication to both the tramway control centre and the passengers.

9.148. Recommendation 7 within Rail Accident Investigation Branch (RAIB) Report 18/2017[65] states:

> *"UK tram operators and owners should install (or modify existing) emergency lighting so that the lighting cannot be unintentionally switched off or disconnected during an emergency (paragraph 470)."*

9.149. On trams that use overhead lines as the power source, it should be possible to raise and lower the current collector manually when the tram has discharged batteries. After raising the current collector manually, the tram should then be capable of being re-energised and charging the batteries using only the supply from the overhead line.

Electrical Equipment Protection

9.150. Electric traction power cables should be routed so that they are protected from mechanical damage. In addition, the following precautions should also be taken (not exclusively):

- Where the cable route passes through a fire barrier, adequate fire stopping should be provided;
- If the cable route passes through the passenger compartment, this should be by the shortest practicable route. Consideration should also be given to protecting power cables against damage that could occur as a result of a collision; and
- A lightning arrestor should be fitted to protect the cables and equipment.

9.151. The operating voltage of electrical equipment in areas accessible to passengers should not exceed 50 V.

9.152. Cubicles containing equipment at electric traction power supply voltage which have to be in the driver's cab shall be locked or appropriately secured. Warning notices shall be displayed; refer to Electricity at Work Regulations 1989.

9.153. Cubicles containing power control equipment that could emit toxic fumes if set on fire should not be ventilated into the passenger compartment.

65 'Overturning of a tram at Sandilands junction, Croydon' (v2.2 –October 2020): https://assets.publishing.service.gov.uk/media/5de79643e5274a06dee23a10/R182017_201022_Sandilands_v2.2.pdf

Control Systems

Traction Brake / Power Controller

9.154. The traction power control system should be of robust design, using safety critical techniques in hardware and software systems to guard against unsafe conditions in failure modes.

9.155. Whatever traction control system is used, it should be designed so as to prevent the following (not exclusively):

- Taking of power or release of the brakes when any external doors are detected as not closed, or when folding or sliding steps or ramps are deployed and not properly retracted;
- Taking of power when the braking systems are not available;
- Enabling of controls, except the emergency brake, from more than one driving position at a time;
- Movement of the tram in a direction opposite to that selected by the tram driver; and
- Should incorporate a DVD whereby periodic positive interaction is required by the driver to affirm attentiveness and they are under control of the tram (refer to LRG 17 for further information).

9.156. A combined traction and brake controller should be fitted.

9.157. Where a single microprocessor is used for safety critical functions in the tram control system, it should be designed to appropriate safety critical standards.

9.158. Jerk rates during starting and acceleration should not exceed those set in 13452:2003.

Brakes

9.159. For braking systems, reference should be made to the guidance given in BS EN 13452:2003.

9.160. In relation to the brake, trams should be fitted with the following:

- A continuous system for the control of the service brake that is operable from the driving position in service on trams coupled in service conditions;
- A parking brake which is automatically applied when the tram is shut down; and
- Brakes that remain partially applied when the tram is brought to a standstill until the controller is operated to take power to move the tram.

9.161. Speed limiting systems and driver inattention systems to automatically reduce tram speeds if they approach higher risk locations at speeds which could result in derailment or overturning must be integrated into the tram braking systems. Refer to LRG 17.0 Driver Inattention Systems Guidance and LRG 18.0 Speed Management Systems Guidance for further information and RAIB Report 18/2017 'Overturning of a tram at Sandilands junction, Croydon' (v2.2 -–October 2020) for further information.

9.162. An electromagnetic brake or brakes acting directly on the track should be fitted to achieve the required performance.

9.163. The braking system should be designed to allow an assisting vehicle (another tram or a recovery vehicle) can operate the brakes on a failed tram if they are operable.

9.164. Consideration should be given to the location and accessibility of brake release controls if a tram is standing in a platform area.

9.165. An irrevocable brake application (one which cannot be reset until the tram has stopped) should, but not exclusively, result from the following incidences:

- A lack of correspondence between vital control systems:
- Insufficient air pressure, hydraulic pressure or electrical supply to operate the service brake or traction control system;
- The loss of brake activating pressure;
- The accidental parting of articulated or coupled trams;
- The unintended deployment of steps or boarding devices; and / or
- An external passenger door is no longer detected as closed.

Brake Performance

9.166. The guidance in BS EN 13452 defines the different levels of braking in standardised terminology which may differ from that used by some UK operators. For clarity, this document uses the terminology of BS EN 13452, for which the common UK equivalents are as follows:

- Service braking: being the normal operating conditions, generally using only the primary braking system, supplemented as necessary under heavy loads and / or at low speeds by the mechanical braking system;
- Emergency 1: Emergency braking –-where the requirement is simply to bring the tram to a standstill by any means, irrespective of the position of the traction and brake controls. Once applied, the Emergency Brake should remain thus and be capable of release only once the tram has come to a standstill. BS EN 13452 calls for this to be at service braking performance level, i.e. it is the brake mode that a tram system might apply if the door loop was broken or the driver was found to be incapacitated;
- Emergency 3: Hazard braking –-where the maximum braking effort is applied in order to bring the tram to a standstill in as short a distance as practicable. The Hazard brake is an 'all or nothing' brake and should be revocable by the action of the driver deselecting it; and
- Security brake: A brake with a higher level of system integrity than emergency 3, applied by the use of an emergency button and irrevocable until the tram is at a standstill and a specific reset is undertaken.

9.167. The parking brake should be able to hold a fully laden tram, or to hold it (in any load condition) and coupled to another (unladen) tram with failed or isolated brakes on the steepest gradient on the system.

9.168. A brake application should occur automatically if a tram rolls back after stopping on an uphill gradient. The tram should stop within 500 mm under all loading conditions on the steepest gradient on the system including a coupled vehicle.

9.169. Equipment should be provided to optimise traction and braking performance under credible adhesion conditions. Such equipment is likely to include sanders and slip / slide regulation systems.

9.170. Assessment should be made to confirm that any magnetic track brakes are physically compatible with the infrastructure of the systems over which the tram is intended to operate. This should confirm that when operated, it will not result in any untoward operation of signalling or communications equipment as a result of transient electromagnetic effects. The performance of the magnetic track brakes is significantly reduced on rails formed from austenitic steel.

Fire Safety

9.171. In general, and unless otherwise specified, it is sufficient for any tram operating under line of sight principles to be designed to a fire standard which is equivalent to that required for buses, as set out in the PCV Regulations.

9.172. Circumstances in which a higher standard, such as BS EN 45545:2 2020, would be appropriate would include the following (not exclusively):

- Operation of trams with high floors that restrict passenger evacuation; and
- Operation over bridges or through tunnels, where there are not easily accessible places of safety for passengers and tram crew.

9.173. Operation through a tunnel does not automatically call for a higher fire standard to be applied in the following situations (inclusively):

- The tunnel is double tracked, provided with a suitable walkway (which may be at track level) and of a length short enough to allow escape to a place of safety away from any smoke or fumes; and
- The tunnel is designed and equipped to the same standards as are applicable to highway tunnels.

10. Tramway Operations

Fatigue Management

10.1. There is no single agreed definition of fatigue, but for the purposes of LRSSB guidance, fatigue will be considered as:

> *"a state of perceived weariness that can result from prolonged working, heavy workload, insufficient rest and inadequate sleep".*

10.2. Sections 2(1) and 3(1) of the Health and Safety at Work etc Act 1974[66] (HSWA) place general duties on employers to reduce risks so far as is reasonably practicable, including risks from worker fatigue.

10.3. Section 7 of the HSWA requires employees to co-operate with their employer by, for instance, ensuring they are adequately rested to do their work safely, and by reporting any concerns about fatigue promptly to their employer.

10.4. The Management of Health and Safety at Work Regulations 1999[67] requires employers to assess risks arising from their operations, including risks from worker fatigue. It also requires employers to put in place effective arrangements for the planning, organisation, control, monitoring and then review these controls. ROGS Regulation 19 is more specific and requires slightly more than the management regulations in terms of recording arrangements.

10.5. When considering fatigue management, reference is often made to the Working Time (Amendment) Regulations 2003[68] (WTR). Employers and other duty holders need to consider and comply with the requirements of WTR. However, it is important to note that by complying with WTR is not in itself sufficient to seek to adequately control risks from workers fatigue, as some work patterns could comply with WTR but still be potentially fatiguing.

10.6. In addition to the above more general duties, Regulation 25 of ROGS places specific fatigue management duties on controllers of safety critical work in the railway industry.

10.7. Further information on the management of fatigue including Fatigue Risk Management Systems, the ROGS 'Nine-Stage Approach for Critical Safety Workers', travel time and reporting is provided in LRG 6.0 Fatigue Management Guidance.

Driver Selection and Recruitment

10.8. The selection and recruitment of the suitable people for the role of tram drivers is of paramount importance to the safe and efficient operation of a tramway. Recruiting the wrong tram drivers or drivers that do not stay in the role is timely and costly to systems and their safety.

66 Health and Safety at Work Act 1974: https://www.legislation.gov.uk/ukpga/1974/37/contents
67 The Management of Health and Safety at Work Regulations 1999: https://www.legislation.gov.uk/uksi/1999/3242/contents
68 Working Time (Amendment) Regulations 2003: https://www.legislation.gov.uk/uksi/2003/1684/contents/made

10.9. As such, valid and appropriate selection criteria need to be employed to select suitable persons for the role of a tram driver. Selection criteria are usually derived from:

- The physical demands of the operation on tram drivers; and
- The aptitudes and mental abilities identified as necessary to ensure competent tram driving after the appropriate training and development has taken place.

10.10. For further information on the recruitment and selection of tram drivers including selection criteria, selection process and testing is provided in LRG 9.0 Driver Selection and Recruitment Guidance.

Medical Fitness

10.11. The duty holder of the tramway should arrange for medical examinations to be carried out by, or under the supervision of, a registered medical practitioner. It is recommended that the medical practitioner has a recognised qualification in occupational medicine or has access to a medical practitioner with such a qualification.

10.12. The individual duty holder's SMS should determine the level of Medical Fitness as required by an individual tramway's characteristics. LRSSB recommend that a minimal level of Medical Fitness will be equal to or more stringent than the level of fitness required to operate a Passenger Service Vehicle (Group 2 driving licence medical standard). Examples of where the requirements may be more stringent than DVLA (Driver and Vehicle Licensing Agency) Group 2 include colour vision, near vision or hearing, depending on the task analysis for the particular tramway.

10.13. For further information on medical fitness including frequency of testing is provided in LRG 11.0 Medical Fitness Guidance.

Management of Drugs and Alcohol

10.14. The TWA sets requirements for individuals and tramways in relation to fitness for work in relation to drink and drugs (including prescribed or medicines that are available for over the counter purchase). In relation to being fit to undertake work, the TWA states:

"a person shall be taken to be unfit to carry out any work if his ability to carry out that work properly is for the time being impaired."

10.15. If a person commits an offense under the TWA, the tramway will also be guilty of the offense unless it has applied all due diligence to prevent an offence being committed. A demonstration of such diligence includes the existence of a drugs and alcohol policy.

10.16. Tramways also have requirements under ROGS 2006 in relation to fitness of safety critical workers for the tasks as defined in Regulation 23 of ROGS, including a requirement that staff are assessed as fit to carry out safety critical tasks. The further requirement to assess staff as fit to carry out safety critical tasks is contained in Regulation 24 of ROGS.

10.17. For further information on the management of drugs and alcohol including the application of the drugs and alcohol policy, its overview, testing regime and process, testing frequency, for cause testing, test results and recording, monitoring and review of the policy is provided in LRG 33.0 Guidance on the Management of Drugs and Alcohol.

Vulnerable Persons

10.18. The Department of Health defines a vulnerable adult as:

> *'a person aged 18 years or over who is, or may be, in need of community care services by reason of mental or other disability, age or illness, and who is or may be unable to take care of him or herself, or unable to protect him or herself against significant harm or exploitation.'*[69]

10.19. An individual vulnerability may be related to a person'' pre-existing mental or physical state (for example, an anxiety disorder, being elderly, sensory impairment, etc.) or could emerge due to an unfolding situation whilst travelling (for example, overcrowding causing mental overwhelming, etc.). Either way, once a vulnerability presents itself, the tramway system should respond in a sensitive, professional and proportionate way to ensure that the person(s) is made as safe as is reasonably practicable whilst in transit.

10.20. Refer to further information in LRG 8.0 Guidance in the Management of Vulnerable Persons that outlines how tram operators may effectively and appropriately respond to vulnerable person(s) travelling on their part of their network. This includes the following:

- Policy and procedures;
- Identifying responsibly persons;
- Strategies for dealing with vulnerable persons;
- Supporting vulnerable people in an emergency;
- Suicide prevention;
- Multi-agency working;
- Information sharing regarding incidents involving vulnerable persons; and
- Collaborative working.

Driver Inattention Systems

10.21. There are many examples of accidents and incidents caused by inattention in line of sight driving in tramways. These range from daily incidents of 'driving without due care and attention' to high profile accidents resulting in multiple fatalities.

10.22. Driver inattention is a possible precedent of overspeed, which in turn describes a technological approach to detect driver inattention and the automatic response from this type of system in the case of continued inattention.

10.23. There are many types and causes of inattention. The following are the most common associated with line of sight driving:

- Incapacitation;
  - Illness;
- Sleep and micro-sleeps;
- Distraction;

69 Safeguarding Adults, Patient: https://patient.info/doctor/safeguarding-adults-pro

- Visual; and
- Cognitive.

10.24. It is important to note that no single approach provides a comprehensive solution to driver inattention and / or driver speed in isolation. However, the joint implementation of driver inattention systems along with vehicle speed management systems acting in synergy delivers a significant reduction in risk.

10.25. Further information on driver inattention systems including examples, causes of inattention, system phases, system approaches, application of approach for inattention, strengths and weaknesses, alerts and intervention is provided in LRG 17.0 Driver Inattention Systems Guidance.

Speed Management Systems

10.26. It is important to acknowledge that for tramways the driver is the key risk mitigator in relation to overspeeding. A suite of controls should be used to minimise the likelihood of overspeeding. These include the following:

- Route knowledge training for tram drivers;
- Implementation of step-down speeds;
- Signage; and
- Automatic Vehicle Speed Management Systems (AVSMS).

10.27. There are different approaches to AVSMS relating to automatic vehicle speed management. This technological approach is intended to automatically regulate the speed of a vehicle if overspeed is detected. The AVSMS currently available fall mainly into two distinct approaches with their own benefits and dis-benefits. These are:

- Location-specific speed management using trackside-based technology (using beacons or balises); and
- Continuous speed management using global positioning system (GPS) / odometer-based systems.

10.28. It is important to note that no single approach provides a comprehensive solution to driver speed and / or inattention driver in isolation. However, the joint implementation of vehicle speed management systems along with driver inattention systems acting in synergy delivers a significant reduction in risk.

10.29. Further information is provided in LRG 18.0 Speed Management Systems Guidance, including the likely benefits and dis-benefits for the two approaches and considerations that should be taken into account when selecting an AVSMS.

Control of Contractors

10.30. Anyone engaging contractors has health and safety responsibilities in relation to the contractors and anyone who could be affected by their activities. Contractors themselves also have legal health and safety responsibilities. As such, every party must understand the part they need to play in ensuring health and safety.

10.31. Refer to LRG 34.0 Guidance on Control of Contracted Works for assistance in managing the risks associated with contractors and visitors performing work on, near or adjacent to premises they control. It also provides information in controlling risk along the supply chain for contracted work on tramways, including operational property or other premises which have an affect or impact upon the operational network.

Weather and Climate Resilience

10.32. Different forms of seasonal weather and climate affect the operation and safety of tramways in varying ways and to different degrees depending on the location of the tramway and its attributes and environment.

10.33. Refer to LRG 37.0 Weather and Climate Resilience for further information to assist tramways in adequately, appropriately and sufficiently preparing and pre-planning to respond to seasonal weather events. This includes items to be considered in the design and construction of tramways, that may later assist when the system is in operation.

Statutory Reporting of Incidents (RIDDOR 2013)

10.34. The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) 2013[70] requires all tramways to report deaths, certain serious workplace accidents, specific and / or occupational diseases and specified dangerous occurrences (near-misses) which occur in connection with work (i.e. tram / tramway related) to be reported to the ORR as the relevant enforcing authority. Anything outside of this should be reported to the Health and Safety Executive (HSE).

10.35. Further information on RIDDOR is provided in LRG 12.0 Guidance for the Statutory Reporting of Incidents (RIDDOR).

Confidential Reporting

10.36. This use of secure reporting ensures that the requirement to cooperate under the ROGS are met and provides a secure way of reporting incidents experienced by tramway staff whilst also maintaining confidentiality.

10.37. A third party confidential reporting system that reaches across any relevant contractual boundaries can benefit the tramway sector as it enables concerns to be raised that may otherwise remain hidden, especially if there is a fear of breaking confidentiality, or where the lines of reporting are not clear

10.38. CIRAS[71] is a confidential safety hotline that is used by most tram operators. It is an independent service which is informed by the advice of a CIRAS committee made up of experts and representatives from across its membership including LRSSB.

10.39. Further information is contained in to LRG 27.0 Confidential Reporting Guidance.

70 The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013: https://www.legislation.gov.uk/uksi/2013/1471/contents

71 Confidential safety hotline for the transport sector: https://www.ciras.org.uk/

Fire and Rescue Guidance

10.40. Tramways have a requirement to comply with the Regulatory Reform (Fire Safety) Order 2005[72] and Fire (Scotland) Act 2005[73] and the Fire Safety (Scotland) Regulations 2006[74]. These sections are specifically intended to support senior managers and managers who have responsibilities at strategic and premises levels in tramway organisations.

10.41. Trams and other vehicles are specifically excluded from the fire safety legislation. Premises used by tramways are included, for example, depots, offices, workshops and tramstops etc.

10.42. The most relevant government published guidance is the Fire Safety Risk Assessment: Transport Premises and Facilities[75] that only applies to England and Wales. However, the advice is generic and applicable to all parts of the UK. It does not set prescriptive standards, but provides recommendations and guidance for use when assessing the adequacy of fire precautions in the premises and facilities. Other fire risk assessment methods may be equally valid to comply with fire safety law. The guide also provides recommendations for the fire safety management of premises. The Scottish Government publication "Practical Fire Safety Guidance for Existing Non-residential Premises"[76] provides generic information covering the same general headings.

10.43. The fire safety measures described in the guides are principally benchmarks. When deciding what fire safety measures are appropriate for premises, the benchmarks can be used as a comparison against what exists in the premises. The benchmarks should not be applied prescriptively to premises, they are not minimum standards nor are they provisions that are deemed to satisfy the legislation. In each case, the measures adopted should be risk appropriate for the particular circumstances in which they are applied. The assessment of risk needs to be specific to the individual premises.

10.44. Guides give an indication as to the measures that may be necessary to manage fire risk. British Standards also cover many areas of fire safety. Fire alarm systems and emergency lighting systems have specific standards relating to design, construction, provision and testing. Other British Standards set out approaches to design, such as BS 9999:2017 Code of practice for fire safety in the design, management and use of buildings[77], intended for use by designers and architects. Relevant standards are signposted in this document.

10.45. Alterations or additions to buildings that impact on fire safety arrangements will require approval from a relevant building control body. Any changes to tramway premises that involve building work or changes of use should result in a reassessment of the fire safety arrangements.

72 Regulatory Reform (Fire Safety) Order 2005: https://www.legislation.gov.uk/uksi/2005/1541/contents
73 Fire (Scotland) Act 2005: https://www.legislation.gov.uk/asp/2005/5/contents
74 The Fire and Safety (Scotland) Regulations 2006: https://www.legislation.gov.uk/ssi/2006/456/contents
75 Fire Safety Risk Assessment: Transport Premises and Facilities: https://www.gov.uk/government/publications/fire-safety-risk-assessment-transport-premises-and-facilities
76 Practical Fire Safety Guidance for Existing Non-residential Premises: https://www.gov.scot/publications/practical-fire-safety-guidance-existing-non-residential-premises-9781788511322/
77 BS 9999:2017 Code of practice for fire safety in the design, management and use of buildings: https://knowledge.bsigroup.com/products/fire-safety-in-the-design-management-and-use-of-buildings-code-of-practice/tracked-changes

10.46. A management commitment to fire safety is important to assist with achieving fire safety standards in premises and in maintaining a staff culture of fire safety. For further information on fire rescue is provided in LRG 20.0 Fire and Rescue Guidance including the following key elements:

- Fire Safety Policy: defining who in the organisation is responsible and what they must do;
- Emergency Fire Action Plan: what should happen in case of an emergency;
- Fire safety information and training: how the building, the fire precautions and people are to be made and kept safe; and
- Recording Information and keeping records.

Tram Maintenance Depot

10.47. Typically, the depot supports project operations through providing a central location and facilities including the following:

- Where trams are serviced, cleaned and stabled;
- Where trams can be serviced, maintained and repaired in accordance with vehicle's maintenance specifications;
- Where project operations staff can sufficiently, efficiently and safely supervise the project operations on a day-to-day basis. Such project operations include the following:
  - Movement of trams and other rail vehicles over the network;
  - Scheduling and executing maintenance of the network;
  - Interaction with other undertakings and / or operators where the network shares infrastructure and / or interfaces; and
  - Interaction with third parties where their activities involve working on or near the network; and
- Where equipment, tools, materials for the maintenance of the network and the trams can be safely and securely stored.

10.48. The depot should supply all the equipment, tools, buildings, vehicles and support services necessary to operate and maintain the tramway to the required levels of dependability, in accordance with relevant standards and guidance, as well as the tramway's own specific performance measures.

10.49. A holistic design and implementation should provide clearly delineated zoning both inside the depot building(s) and external facilities which, as a minimum, will need to identify and signpost the following (not exclusively):

- Safe walking and equipment transportation / movement routes;
- Areas where:
  - Protective clothing and / or equipment is required;
  - Public access is prohibited;
  - Highway vehicles and / or pedestrian access is prohibited; and
  - Restricted working zones, for example: height, weight restrictions and working near OLE.

10.50. The holistic design and implementation of each and every depot should provide a high quality, cost-effective and sustainable facility which fulfils the functional requirements, project operations and also respects its surroundings.

10.51. For further information on maintenance depots is provided in LRG 30.0 Depot Control Centre.

Operation Control Centre (OCC) Human Factors

10.52. The design of an OCC should adequately support staff whose role it is to help provide safe, effective and efficient tram services. A human factors approach can help optimise the design and therefore operations for new OCC as well as when amending existing facilities.

10.53. Central to this is the concept of human factors integration as a way to address human factors (HF) topics either as part of a wider project that is delivering an OCC, or for an OCC project. This includes the following (not exclusively):

- HF activities should inform (and be informed by) engineering practice and project management processes early and then throughout the project;
- Getting feedback from end users through use of structured approaches; and
- Having HF competence represented as part of a multi-disciplinary team approach to design to assist overcoming design challenges and to create an optimal design.

10.54. For further information on operation control centre human factors is provided in LRG 29.0 Operation Control Centre Human Factors. This includes the following:

- Approaches for new and existing OCC projects;
- HF competence and multidisciplinary teams;
- The specific HF activities and studies that may be required;
- Applicable HF standards; and
- How HF work feeds into the wider project.

Depot Supervision

10.55. To safely and efficiently fulfil project operations after the successful conclusion of any works which are needed to implement or modify a network, the following factors need to be considered:

- Supervision and management of the project operations and network assets; and
- Systems, technologies and / or supporting processes to plan for and implement project operations.

10.56. For further information, including the following, refer to document LRG 31.0 Network Supervision Management Guidance:

- The role of the contracting party undertaking supervision and management;
- The services and their performance;
- Asset management and performance;
- The role and functionality of the OCC;

- The functionality and composition of the supervision and control system to support OCC functions; and
- Technologies which deliver the necessary network security requirements.

Testing and Commissioning

10.57. A key part of introducing a tramway into public service is to assure that the services can be consistently delivered in accordance with the performance measures and that project operations can be consistently undertaken in an acceptable safe manner. To achieve this, a suitable regime of safety verification and validation (V&V), developed jointly with the operator and operation and maintenance subcontractor needs to have been successfully implemented before the commencement of passenger services.

10.58. As such, the V&V scheme should form an intrinsic part of the network's implementation plan and correlate with the SMS. This would include setting out a methodology and approach that demonstrates acceptable safety in turn and underpins the design, implementation and bringing them into public use. These processes will allow the relevant duty holder(s) to sign-off the relevant certificates.

10.59. Further high-level principles can be found in LRG 32.0 Testing and Commissioning Guidance, which includes the following:

- Describing the process for accepting the network into service;
- Identifying and describing appropriate terms and conditions to support network acceptance;
- Describing the sequencing of tests and test gateways;
- Identifying roles and responsibilities of the contracting parties in delivering network acceptance; and
- Compliance with ROGs.

Appendix A: Highway and Tram Traffic Signal Integration

1) This appendix along with Section 8 provides good practice on the integration of LRT signalling with highway traffic signalling.

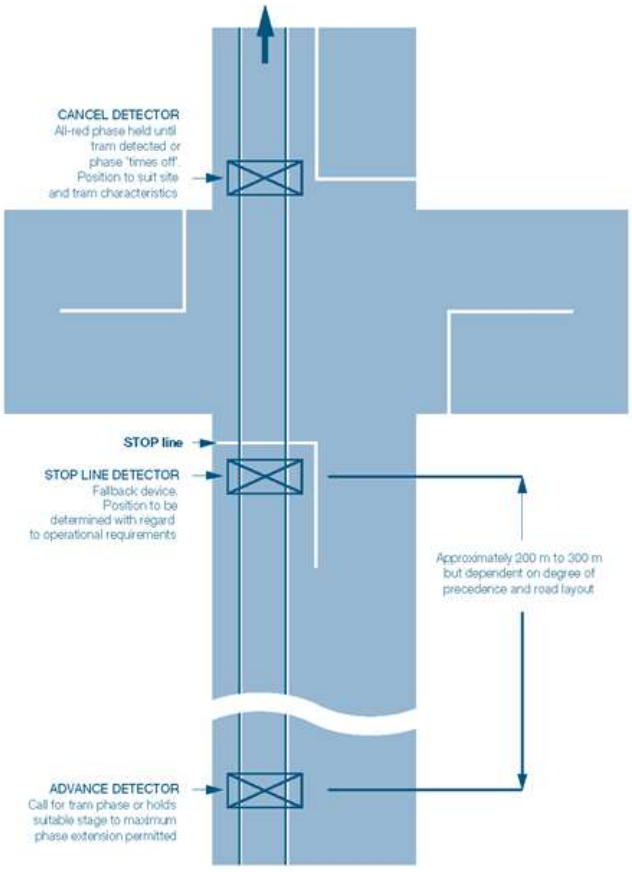
2) The detailed arrangements of any highway and tram traffic signal integration should be agreed with the Highway Authority.

3) To give the appropriate priority to trams, the tram phase (when demanded) may need to run before any parallel or similarly compatible phase for other highway users is initiated. The tram phases should terminate at the same time as any parallel stage or phase for other highway vehicles.

Controlled Intersections

4) Tram detectors should be provided where highway traffic light control systems employ some degree of demand dependency. The detector's function is to register a demand in the highway traffic signal controller to call up the tram phase in the next appropriate stage in the sequence. Figure App A.1 below indicates typical tram detector positions.

Figure App A.1: Typical Tram Detector Positions



5) Tram selective detectors should only respond to trams. Selective detectors may also pass only information for tramway operational purposes.

6) A *Stop* line detector should be provided as shown in Figure App A.1. This should register a tram demand if none is already present

7) If the tram *Proceed* signal (as shown in Diagram 3013.2 of the TSRGD) is already present, departure from the *Stop* line detector may initiate a red period.

8) A cancel detector should be provided on the downstream side of the S*top* line to enable the red period to be terminated before the end of the maximum period once a tram has cleared the intersection.

9) The minimum provision should be a stop line detector and a cancel detector.

10) An advanced detector may be provided further upstream of the *Stop* line detector on the tram approach to secure a tram *Proceed* indication without requiring the tram to stop at the *Stop* line. The advanced detector may then be used to prioritise the tram phase if required, including making provision for the passage of a tram in the opposite direction on a parallel track.

11) The maximum degree of priority that can be given to a tram will depend on the:

- Distance of the advanced detector from the Stop line;
- Tram running speeds; and
- Staging and timing arrangements for the intersection.

12) Further advanced detectors may be necessary to allow the tram the maximum precedence, to permit it to run unimpeded through the intersection, or to improve junction capacity for other highway users.

13) The distance between the outermost of advanced detectors and the intersection will be governed by the maximum permitted speed of the trams and the maximum attainable speed, whichever is less, as well as the time taken for the road traffic signal controller to change to the appropriate stage. The objective is that the *Proceed* aspect is shown before or just as the tram reaches an overall service braking distance (including reaction time) from the *Stop* line.

14) The signal aspect *Cluster* (as shown in Diagram 3013.5 of the TSRGD) should be displayed for a period commensurate with the service braking performance and approach speed of the tram. A shorter period, commensurate with the emergency braking performance, may be used if the signalling design ensures that a signal will only return to *Stop* as a tram is approaching under exceptional conditions, for example an emergency services vehicle hurry call or a fault. However, the period should be consistently applied throughout each individual system.

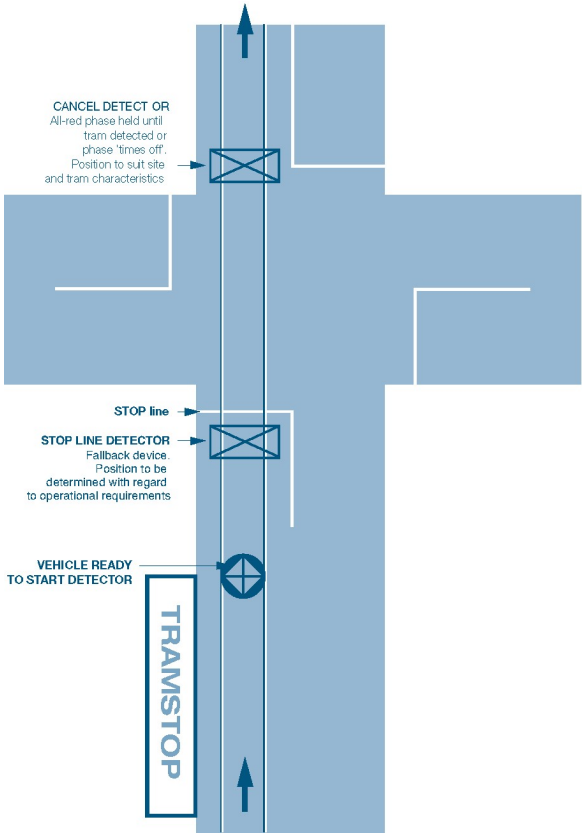
15) The nominal time for this *Cluster* aspect to be displayed is normally five seconds. However, this may be varied between systems according to local geographic, climatic and traffic conditions, which in turn may affect the braking performance of the trams.

Priorities at Controlled Intersections

16) *Hurry call* signals for emergency service vehicles should override all other demands of the LRT signals.

17) Where a tramstop is located between where the advanced detector would be positioned and an intersection, a tram ready to start (TRTS) detector should be provided so that the tram driver can initiate the tram phase when the tram is ready to depart from the tramstop. Figure App A.2 below shows a tramstop with a TRTS detector.

Figure App A.2: Tramstop With a TRTS Detector



18) Where a tramstop is so close to the intersection that the TRTS detector would be located with or very close to the *Stop* line detector, then the TRTS detector should replace and also assume the role of the *Stop* line detector.

19) If the last detector before a junction is a TRTS detector, but the tram can move forward from this detector to the *Stop* line at the junction, sufficient means should be provided for a tram phase demand if the driver forgets to use the TRTS feature and moves forward off the detector.

Signalled Pedestrian Crossings

20) A signalled pedestrian crossing located at a signalled highway intersection where tramway signals are in operation should be controlled by the road traffic signal controller.

21) An inhibit should always be installed to prevent the LRT signal changing to stop after the tram is within its service braking distance (although the inhibit may be subject to a timeout if the tram is unduly delayed).

22) Further information is provided in LRG 24.0 Pedestrian Safety Guidance and LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users.

Road Traffic Signal Controllers

23) Communication is required between the road traffic signal controller and any tram detectors. The road traffic signal controller should analyse the information from these tram detectors to Further information is provided in Refer to LRG 24.0 Pedestrian Safety Guidance and LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users.

Road Traffic Signal Controllers

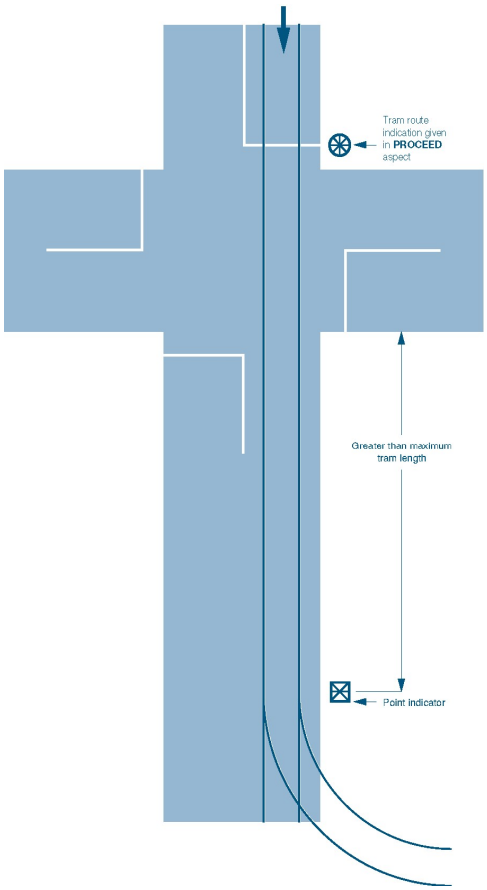
24) Communication is required between the road traffic signal controller and any tram detectors. The road traffic signal controller should analyse the information from these tram detectors to determine when to call and cancel the tram phases. Tram route information for the intersection may be supplied directly by the detectors or from a tramway traffic control facility.

25) In some cases, it may be necessary to provide an interface unit between the road traffic signal controller and the tram detection equipment.

26) The maximum distance for points to be located downstream of an intersection is that of the length of the tram in order that the driver can reliably observe the lie of the points.

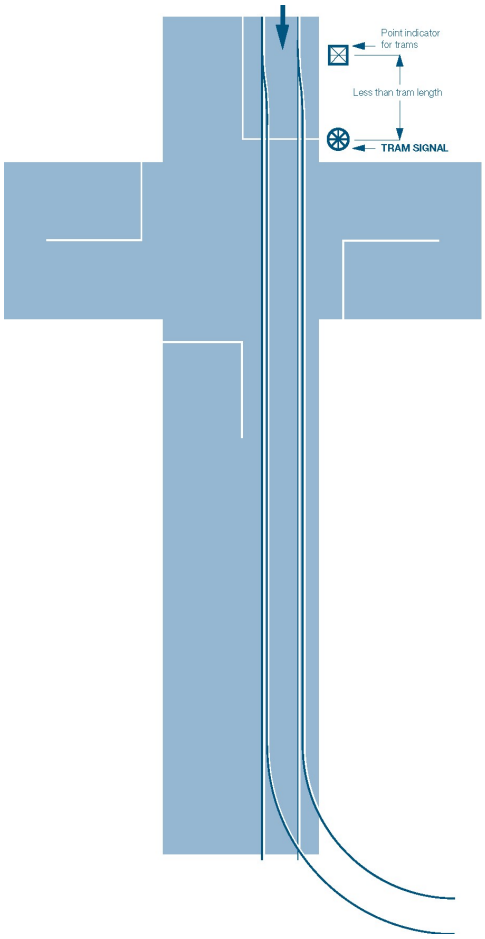
27) In situations where points are located at a greater distance, information regarding the lie of the points will not be provided to the LRT signal, but the proposed route may be indicated in the *Proceed* aspect. This situation is illustrated in Figure App A.3 below.

Figure App A.3: Tram Junctions With Points After Highway Intersection



28) Where the tram turnout lies within a tram length of an intersection, the points should be located on the approach to the intersection to avoid a tram stopping on the intersection awaiting the points being set and a *Proceed* aspect being given. This situation is illustrated in Figure App A.4 below.

Figure App A.4: Tram Junctions With Points Before Highway Intersection



29) Local point indicators should be provided adjacent to the point ends. Only these indicators, and not the LRT signal, should show the lie of the points.

30) The routing of trams and the detection and control of point mechanisms should be wholly contained within the tramway control system.

Urban Traffic Control Systems

31) The LRT signal system may be interfaced with an urban traffic control system (UTC). The interface will depend on the individual UTC used and also the coverage of the UTC as in some areas they are

regional, and in others, they are within local authority boundaries. However, suitable tram detector arrangements in keeping with those described above are required for all types of UTC.

32) Road traffic signal controllers should comply with Traffic Open Products and Specifications (TOPAS) Ltd in document 2500B Specification for traffic signal controller[78].

33) Regulations removed the requirement for traffic control equipment to be of a type approved by the SoS. Recognising that the removal of type approval meant there was a need for a body to maintain standards, the DfT has worked with traffic authorities as purchasers of this equipment and sector representatives to set up TOPAS. TOPAS maintains a product register and the suite of traffic regulation technical specifications previously maintained by the Highways Agency (now National Highways). To be included on the register of TOPAS products, manufacturers self-certify that their equipment meets the relevant specification and has passed the relevant tests. This enables purchasers to check that equipment they are buying meets national good practice.

Equipment Monitoring

34) The road traffic signal controller should be designed to monitor the failure of lamps in the LRT signal.

35) The road traffic signal controller should be designed to monitor tram detectors to ensure they are functioning correctly and do not cause any conflicting aspect to be shown.

36) Where tramway systems operate within a UTC area, the road traffic signals will be monitored regularly. In addition, monitoring of the LRT signal lamps is required.

37) In order to prevent a misleading LRT signal aspect being shown in a combined, single-unit array, individual lamps or clusters of a minimum of three out of the five LED, lamps or clusters should be lit. Where the aspect is provided by a fibre optic or LED display giving the appearance of a continuous band, the monitoring system should reveal the condition when less than 60% of the band is visible or the light output of the band has fallen below 60% of the normal. In either case, provision should be made for the control room or UTC to be alerted. Requirements for signal performance is specified by TOPAS 2514B[79].

38) Where tram systems operate outside UTC areas, or in towns and cities without UTC, a monitoring system should also comply with TOPAS 2514B.

39) The default mode during the failure of any detector should provide the following facilities as a minimum, unless an agreed equivalent system is installed:

- The failure of an advanced detector should not register a demand for a tram phase;
- The failure of a Stop line detector should register a permanent demand for a tram; and
- The failure of a cancel detector should cause the all-red period to run to the maximum time permitted (sufficient to allow a tram to clear the intersection in accordance with current traffic management practice).

78 TOPAS document 2500B Specification for traffic signal controller: https://topasgroup.org.uk/media/TOPAS-2500B.pdf

79 TOPAS 2514B Tram Signals: https://topasgroup.org.uk

40) An alternative means of registering a tram demand is required in the event of failure of a detector. Some alternatives are suggested below:

- TRTS detector which doubles as a Stop line detector;
- The creation of a plausible demand that can be used to call up a tram phase if any detector fails and where other detectors are available;
- The recognition of a Stop line detector registering a permanent demand, by reference to inputs from other detectors may enable the demand to be downgraded to a non-priority demand. Where this is not possible, a tram phase should have a maximum time allotted to it, following which it should be shut down and the tram phase thereafter appear automatically at a fixed time within each cycle, either running concurrently with other appropriate phases or separately;
- A key-operated override switch located at the local road traffic signal controller or adjacent to the signal can enable a tram input command to a road traffic signal controller if any of the tramway equipment upstream of and including the tramway interface unit should fail; or
- Remote input from the UTC system / tramway control room to insert a tram demand via the UTC equipment to assist trams that are unable to indicate their presence to the local highway traffic signal equipment.

Approval of Equipment

41) All equipment shall be approved before being put into service. This includes the following equipment (not exclusively):

- Used to control road traffic on the highway,
- Connected to a road traffic signal controller, and / or
- Housed with the road traffic signal controller.

42) Further information regarding approval procedures can be obtained from the TOPAS documents 2500B and 0600E[80], and also in document TD 07/07 of the DMRB.

43) For traffic signal controllers this approval extends to the content of all instructions either stored in or executable by the controller, not simply the hardware.

44) Systems employing radio techniques shall be approved by the Office of Communications (Ofcom)[26].

80 TOPAS 0600E: A Self-Certification Procedures for Statutory Approval of Traffic Control Equipment: https://topasgroup.org.uk/media/Topas-0600E-Final_1.pdf

Appendix B: Heritage Tramways

1) This appendix provides information on heritage tramways and includes the use of historic trams on new or existing tramways, and the design and use of replicas of historic trams.

2) A 'Heritage Tramway' is defined in Regulation 2 of the Health and Safety (Enforcing Authorities for Railways and Other Guided Transport Systems) Regulations 2006.

3) Heritage trams may operate either on dedicated heritage systems or on systems that are normally operated by modern trams.

4) Some heritage tramways possess works, plant and equipment including trams which do not meet the terms of this document in all respects. Where such works, plant and equipment have been in use over a sustained period, and these disparities have been countered by suitable operating practices and staff training, this document should not be taken as suggesting that these arrangements should be disturbed so long as the works, plant and equipment continue to be used with these safeguards.

5) This document should be followed whenever it is reasonably practicable to do so. This particularly applies to matters of electrical safety and to clearances between trams and structures.

6) In this appendix:

- Open-top tram means a single-deck tram without a roof, or a double-deck tram without a roof over all or part of the upper deck; and
- Open-sided tram means a tram having open sides giving direct access to the seats (a 'track' tram or 'combination' tram) or a tram having side windows capable of being stowed to a substantial extent within its body sides or roof (a 'semi-convertible' tram).

Tramway Clearances

7) It may not be practicable to establish a precise kinematic envelope for each tram on a heritage system. However, it should be possible to establish a generous tramway path to cover all trams used or likely to be used on the tramway.

8) On tramways that operate open-sided trams, the clearances given in Section 3 and Appendix G of this document should be increased so that there is at least 830 mm between the SE and any structure, including OLE and lighting poles. This clearance may be reduced when restraints are fitted to the sides of such trams.

9) On tramways that operate open-top trams, the clearance to the underside of a structure over the tramway from the floor of the open deck should not be less than 2000 mm. This clearance should be increased to 2750 mm if there are overhead electrical conductors.

The Infrastructure

Track

10) The weight of rail should be appropriate to the maximum axle loading and permitted speed. Section 45 of the TWA 1992 enables directions to be given as to the axle loadings and speeds.

11) On ballasted track, the ballast should be level with the top of the rail to allow any drop-down lifeguards to function efficiently. This may be unnecessary if the line is fenced or other means of deterring unauthorised access to the track are in place.

Electric Traction System

12) The minimum wire height above the floor of the upper deck of any open-top tram should not be less than 2750 mm. Where this is not practicable, any special precautions and operating instructions should be discussed with the ORR.

13) Refer to LRG 15.0 Stray Current Management Guidance for further issues of stray electrical currents involving heritage tramways.

Control of Movement

14) Indicators to show the lie of any facing points may not be required. However, if they are not required, the operating procedures should require each driver to confirm the correct setting of the switch blade or blades before passing over the points.

15) A simple form of access control instead of an interlocked signalling system may be used on lines with single-line working. The method to be adopted should be discussed with the ORR.

Rolling Stock

16) A tram may employ horses, internal or external combustion engines, cables, or electricity to provide traction power. information on electric traction power is given in Section 7 of this document.

17) This document may not be appropriate for brakes, lifeguards and lighting for horse-drawn trams. In these cases, refer to the guidance note relating to the operation of these trams that has been produced by the Heritage Railway Association.

18) The external lighting requirements for trams given in Section 9 of this document may be relaxed. As a minimum, one or more headlamps and a tail lamp should be provided. Where reasonably practicable, all trams apart from horse-drawn trams that are operating in highways with other types of highway traffic should be fitted with brake lights even though they may not have been originally fitted to the vehicle.

19) The braking performance of heritage trams may be less than that stated in Section 9, providing the speed of operation and the operating rules of the system are appropriate to the actual braking performance.

20) Coupled trams should have compatible buffing and draw gear and also braking systems. They should have comparable end-loading strengths. This guidance may be set aside if it becomes necessary to recover a failed tram in non-passenger service.

21) Coupled trams should have compatible buffing and draw gear and also braking systems. They should have comparable end-loading strengths. This guidance may be set aside if it becomes necessary to recover a failed tram in non-passenger service.

22) Heritage trams are not required to comply with Section 9 governing fire safety, except that suitable fire extinguishers should be carried.

Underrun Protection Devices

23) Heritage trams are traditionally fitted with a variety of underrun protection devices (lifeguards) and in the case of some early or very slow speed trams no frontal underrun protection is provided.

24) Underrun protection devices on electric trams may include drop down ‘gate and tray’ systems, sprung tray systems, ‘providence’ lifeguards or a solid blade system. This is an indicative list, as there were experimental systems in use on first generation tramways. In addition, bogie trams may be equipped with side protection between the bogies.

25) Coupled trams should have compatible buffing and draw gear and also braking systems. They should have comparable end-loading strengths. This guidance may be set aside if it becomes necessary to recover a failed tram in non-passenger service.

26) Steam tram engines are fitted with skirting to not exceed a gap of 100 mm (4 inches) from the highway surface, but from 1890 ‘life protectors’ were an additional requirement.

27) Cable trams and horse drawn trams, that operate at very slow speed, not exceeding 12 km/h (7 miles per hour), are not necessarily fitted with underrun protection. Some may be fitted with small ‘plough’ blades or brushes to remove or divert objects from in front of the wheels.

28) Certain works cars or tramway maintenance vehicles are not fitted with underrun protection by the very nature of their usage, for example snowploughs.

Open–top Trams

29) For open-top trams, adequate clearance should be provided between the upper deck floor or any place where a person could reasonably be expected to stand and any exposed live electrical equipment. This clearance and other arrangements to protect against risks from an overhead power supply conductor should be discussed with the ORR including any special operating instructions.

30) Coupled trams should have compatible buffing and draw gear and also braking systems. They should have comparable end-loading strengths. This guidance may be set aside if it becomes necessary to recover a failed tram in non-passenger services.

31) For open-top trams, adequate safeguards should be in place to minimise the risk of people being struck by the overhead power supply collector of any such tram as a result of the de-wirement or rotation of the collector including if any part of it became detached.

32) Edge protection commensurate with the height above ground should be built into the tram to protect against falls.

Appendix C: Tramway Vehicles Not Carrying Passengers

1) This appendix relates to tramway vehicles that do not carry passengers including works trams.

2) Trams that do not carry-passengers should follow the design principles detailed in this document where practicable or appropriate. However, where such trams are infrequently used or unpowered or are self-propelled works trams, some features may be difficult to achieve or may be considered unnecessary.

3) Vehicles used for tramway maintenance may be exempt from some of the operational provisions for trams that carry passengers. The degree of exemption may depend on the following:

- The type of tramway system;
- Whether the vehicles are used at the same time as passenger services; and
- Whether the vehicles are self-propelled or not.

4) Unless they have been specifically excluded, works trams and other similar vehicles should follow Section 9 of this document for the following (refer also to BS EN 15746-4:2020[81]):

- Underframe and body;
- Driver's cab;
- Mirrors;
- External lights and audible warning devices; and
- Braking performance.

5) Works trams are not required to follow the guidance for couplers, so may be non-folding and need not be fitted with fenders or protective covers. However, following a risk assessment, additional operational control measures may be required to minimise risk to pedestrians and other vehicles.

6) Unpowered works vehicles are not required to follow the guidance for the following:

- Underrun protection;
- Skirts; and
- Lighting and audible warnings (but they shall carry side marker lights).

7) Unpowered works vehicles used at the extreme leading end of a works tram should carry the appropriate forward lighting and be equipped with a suitable position from which a member of the staff can safely operate the emergency brakes and an audible warning device. Vehicles at the rear of a tram should carry the appropriate rear lights. End outline marker lights are not required unless the top of the vehicle body is more than 2500 mm above rail level.

8) Unpowered vehicles should be chocked when isolated.

81 BS EN 15746-4:2020 Railway applications. Track. Road-rail machines and associated equipment - Technical requirements for running, travelling and working on urban rail

9) Powered vehicles that do not carry passengers that are used exclusively within off-street possessions, for example grinders and tampers, may not need to comply with the lighting requirements described in Section 9.

Appendix D: Signals and Point End Indicators

1) This appendix provides examples of LRT signals and point end indicators as referred to in the main document.

Table App D.1: LRT Signals

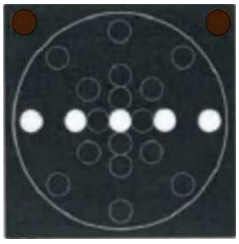
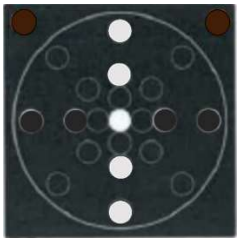
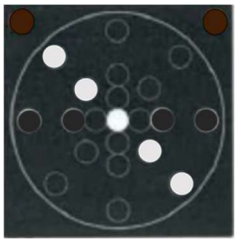
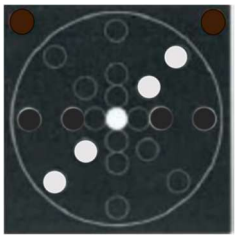
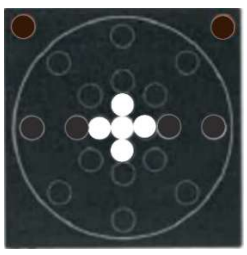
Designation	Signal Appearance	Meaning	Explanation
Signal Diagram 3013.1	Five white dots horizontally and equally spaced 	Stop	Equivalent to a road traffic red signal aspect. These signals are found located at at-grade road crossings, junctions and signalled pedestrian crossings.
Signal Diagrams: **3013.2**	Five white dots vertically or diagonally equally spaced 	Proceed Ahead	Equivalent to a road traffic green signal aspect. The diagonal aspects indicate authority to proceed left or right.
3013.3		Proceed to the left	
3013.4		Proceed to the right	
Signal Diagram 3013.5	Five white dots in a close formed cluster 	Give way / prepare to stop	Similar to a road traffic amber signal aspect. *The indication that the signal is reverting to a stop aspect.*

Table APP D.2: On-street LRT Signals

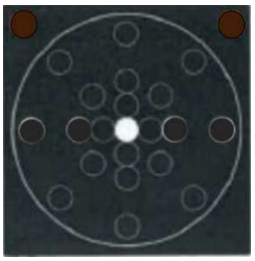
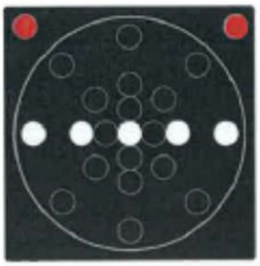
Designation	Signal Appearance	Meaning	Explanation
On-street signal	A single central white dot 	Traffic Signal Controller failed. Seek advice from OCC	A vehicle may not cross the junction.
On-street signal	Five white dots horizontally and equally spaced with small, illuminated indicators in top corners. 	Pre start to proceed- close doors	Confirmation to tram driver that demand has been accepted by the traffic controller.

Table APP D.3: Off-street LRT Signal to Railway Signal

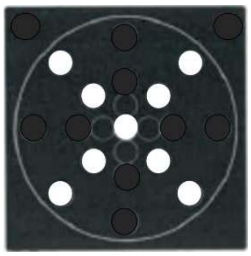
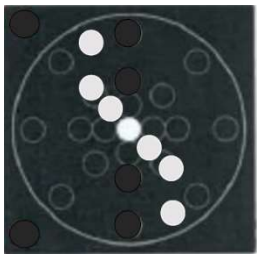
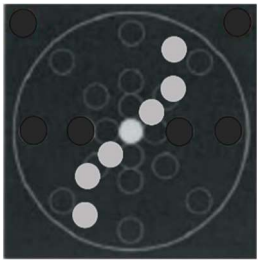
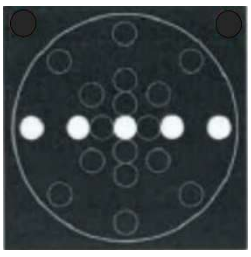
Designation	Signal Appearance	Meaning	Explanation
Advance warning of a railway protecting signal – for tram train interface areas	Nine dots equally spaced forming a St Andrew Cross 	Proceed with caution	Route to the mainline has not been authorised and the line ahead is not clear. Stop at the next signal unless Proceed is given (likely to be railway multiple aspect type This is placed before a mainline three aspect signal red/green/ yellow.

Table APP D.4: Additional and Alternative Signal Indicator Formats Off-street

Designation	Signal Appearance	Meaning	Explanation
SPAS indicator optional	Flashing blue LED or Xenon indicator 	Signal Passed At Stop	A vehicle has entered a single line section without authorisation and potentially another vehicle is already in the section.

Table APP D.5: Point Position Indicators

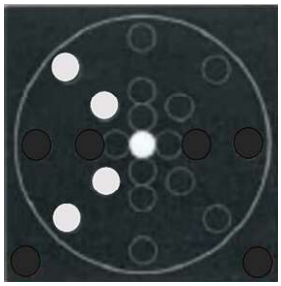
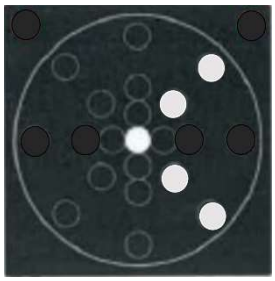
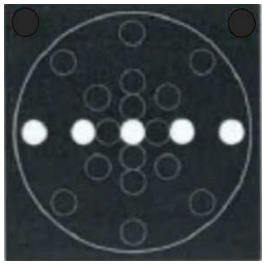
Designation	Signal Appearance	Meaning	Explanation
Facing Point Indicator	Seven White dots equally spaced forming a 'dog leg' (alternative colour is amber on some systems) 	**Points Set Left**	The points have been set, checked for locking (powered points only) and detection from the facing view.
Facing Point Indicator	Seven White dots equally spaced forming a 'dog leg' (alternative colour is amber on some systems) 	**Points set Right**	The points have been set, checked for locking (powered points only) and detection from the facing view.
Facing Point Indicator	Five white dots horizontally and equally spaced (alternative colour is amber on some systems) 	**Points out of correspondence** do not proceed. Manual operation only by procedure	Stop. The points have not been confirmed as set or locked.

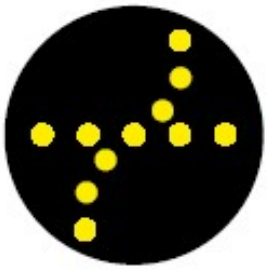
2) Different styles of border to signal heads may be used to differentiate between signals that apply on highway sections, tramway only sections or point dependant signals. The styles could include colouring, for example, yellow, white or black but must be consistent throughout the entire network.

Other Special Signal Formats

3) Other signal formats not specified above may be considered after undertaking the appropriate risk assessment and have no conflict with the recommended signs and signals above. Examples are shown below.

Table APP D.6: Special Signal Formats

Designation	Signal Appearance	Meaning	Explanation
Trailing Point Indicator	Five white dots equally spaced forming a chevron to the right 	**Points Set Left**	The points have been set, checked for locking and detection from the trailing view. They must be set to avoid trailing through.
Trailing Point Indicator	Five white dots equally spaced forming a chevron to the left 	**Points set Right**	The points have been set, checked for locking and detection from the trailing view. They must be set to avoid trailing through.
Trailing Point Indicator	Five white dots horizontally and equally spaced 	**Points out of correspondence**	Unsafe to continue. The points have been set, checked for locking and detection and failed.

Designation	Signal Appearance	Meaning	Explanation
Facing Point Indicator (Used at Manchester Metrolink)	A dog leg set of orange lights angled to the right and a horizontal row of orange lights 	**Points not reset**	Stop and contact the OCC. Only proceed on OCC instructions. The points have remained as set for the previous tram and have not moved for the subsequent tram's direction of travel.

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Appendix E: Pedestrian Issues

1) This appendix gives additional information on the integration of tramways into pedestrian environments and is to be read in conjunction with LRG 2.0 Guidance on Tramway Crossings for Non-Motorised Users and LRG 24.0 Pedestrian Safety Guidance.

Design of Alignment

2) The design of the track alignment should consider potential pedestrian access, in order to minimise the risk of serious injury.

3) This is particularly relevant on vertical curves or where there are tight clearances, for example, where there is a large overhang at the ends of the tram. The radius of all horizontal and vertical curves should be reviewed in conjunction with the characteristics of the tram. Recognising limitations of available trams is an essential interface identification requirement in relation to the local topography. Refer to LRG 16.0 Wheel Rail Interface Guidance for further information.

4) When planning a new system or route, the parameters and limitations of available trams, as well as any new vehicles being brought into service should be considered and taken into account.

Track Geometry

5) In order to minimise any risks to pedestrian safety, consideration should be given to the following at the design stage (not exclusively):

- Effects of alignment on tram spatial positions relative to the highway;
- Hog curves and sag curves – both horizontal and vertical;
- Pedestrian protection from underrun;
- Gap between tram and highway;
- Position of wheels with reference to the tram body;
- Clearances to pedestrian's etc.;
- Assessment of risks in presenting false security to pedestrians;
- Positioning of the alignment to maximise available space for pedestrian use, and taking account of parking, loading, footfall, etc.;
- Consideration of consequences of derailment and how this interacts with the pedestrian environment; and
- Elimination of powered points in public areas.

6) In relation to the elimination of powered points stated above, if powered points cannot be eliminated in a pedestrian area and are unavoidable, protective measures should be put in place, for example, the points are only operated when tram is in close proximity i.e., visible by the driver. Refer to Point Control, Detection and Indication in Section 8 of this document.

7) In relation to horizontal curves above, pedestrian desire lines need to be considered.

Desire Lines

8) In the early stages of the infrastructure design, consideration should be given to pedestrian movements in the vicinity of the tramway system, including movements across it.

9) Pedestrian desire lines may need to be modified to reduce risks; they may be affected by some of the sighting hazards listed below.

10) The design of the tramstops and pedestrian access to it and across it should, as far as possible, minimise the desire to cross the track at places other than designated crossing points. Pedestrians, including passengers, should be encouraged to use defined crossing points. Particular care should be taken at tramstops where trams may possibly be required to stop only when requested.

11) Warning signs should be placed such that pedestrians are clearly warned of the dangers of not keeping to footpaths designed to direct passengers to designated crossing points.

12) The ground surface including finishes should be finished flush with the rail head within a tramstop area and at least within 1m of a crossing point.

Sighting Hazards

13) The tramway should be designed to minimise the number of sighting hazards so that tram drivers and pedestrians can easily see and be aware of each other, particularly considering the following issues (not exclusively):

- Highway junctions;
- Vehicle inter-visibility;
- Vehicle parking;
- Bus stops;
- Landscaping / trees and vegetation;
- OLE, signs and lighting poles;
- Street clutter, for example, advertisement boards;
- Light to dark transitions and vice versa;
- Lighting levels;
- Street furniture and guard railing (refer to the Manual for Streets for further guidance); and
- Tunnels / underpasses.

Pedestrian Management

14) The design of a tramway should take account of pedestrian movements associated with major buildings, schools, main line railway stations etc. where there are potentially a large number of pedestrians, including those who are distracted and not giving the presence of trams their full attention. Refer to LRG 24.0 Pedestrian Safety Guidance for further information.

15) Active and passive guidance measures to manage pedestrians and delineate swept path as far as practicable should be considered in the design as necessary. This can vary depending upon the

location and may need to consider event management, for example during Christmas time or when there is a football match etc.

16) Within the tramway there may be specific areas requiring pedestrian access, areas where pedestrians are prohibited (such as next to a railway line) and areas where pedestrians should be discouraged from walking following any risk assessment, for example within a tramstop.

17) Methods of pedestrian control should be coherent and consistent throughout the system and include the following:

- Provision and delineation of pedestrian crossings;
- Signage;
- Active deterrents such as barriers, paving, planting, etc.;
- Passive and active deterrents such as marking the tramway path should be considered, for example, LED lights activated by the approach of a tram; and
- Defined walkways on bridges, viaducts and other restricted areas.

18) Where deterrents are provided to separate pedestrians and trams, the deterrents should not also introduce potential trapping hazards with the tram body (side or front) or underside.

19) There may also be areas where specific controls or specific measures need to be engaged, for example, outside schools or football stadiums. Whilst measures may be unique on a system or route, they should be aligned to the above list as far as practicable for consistency.

Junction Design

20) Adequate provision should be given to pedestrian crossing phases at signalled junctions. Wider area impacts on highway traffic and pedestrian flows should be considered at an early stage of developing the design of a tramway and subsequently during detailed junction design and construction.

21) Non-signalised junctions should conform to necessary visibility requirements for both pedestrians and vehicle drivers. These should be in conformance with the DfT requirements given in the Manual for Streets.

Pedestrian Crossings

22) Uncontrolled pedestrian crossings with normal passive signing should be the default option even where other signalling is present unless such signing proves inadequate. Consideration should be given to users that might need to take advantage of signalling them across the tramway, especially if it is provided for other highways at the junction.

23) Where demand-dependent tramway signalling could impact upon the available time allocated for pedestrians to cross in the event of two trams opposing the same junction simultaneously from both directions, or the intensity of tramway traffic is well below the criteria normally applied to justify signal controlled crossings, experience of UK tram systems is that pedestrians generally ignore signalled crossings. To reduce risk in these circumstances, un-signalled crossings should be

used except where the mutual visibility of all highway users is inadequate. Exceptions to this include the following (not exclusively):

- Where the crossings are common to other traffic sharing the same lane or on adjacent lanes with no separation;
- Where the crossings form part of a fully-signalled junction and separation of the tramway;
- Pedestrians crossing at the location is not practicable; or
- Where tram and pedestrian flows are very high.

24) Every effort should be made to achieve consistency along a tramway and, as far as possible, between tramway systems in the UK to avoid confusion to both tram drivers and pedestrians. The following examples, when considered as good practice, should be cascaded forward from one system to the next:

- Crossing layout;
- Tactile colouring and texture;
- Signage; and
- Guard rail configurations.

25) The practice of the provision of signals at highway junctions and pedestrian crossings varies between local highway authorities, and can be based on practical experience of accident rates (in the absence of a tram). These regional variations for each type of junction need to be borne in mind when assessing tramway junctions where tramway systems extend beyond one single local highway authority boundary.

26) The use of zebra crossings over tramways is prohibited in accordance with TSRGD.

Operational Considerations

Sighting

27) Sighting studies should be carried out at an early stage of the design of any tramway scheme, and should continue throughout the development of the design. When carrying out sighting studies, potential maintenance issues, for example soft landscaping design, should be considered as well as requirements to acquire land to provide adequate sighting etc.

28) Issues raised as part of sighting studies should be incorporated into the hazard log in order to maintain the validity of the safety acceptance process.

29) The positioning of driver information signage and potential for driver distractions should be considered at the early stage of design.

30) When the tramway is in operation, the Operators' SMS should provide for dealing with temporary works external to the tramway for example highway works, scaffolding etc. For further information on works, refer to LRG 34.0 Control of Contracted Works Guidance.

Speed

31) Aspirations for run-times should be realistic taking account of all practical operating limitations, both when in design as well as operation.

32) Both geometric and operational speed limits need to be considered in parallel.

33) Operating speeds in pedestrian areas should consider random or unplanned movement of pedestrians or desire lines including frequency.

34) Refer to LRG 18.0 Speed Management Systems Guidance for further information in relation to speed management systems.

Tram Underrun

35) In defined pedestrian areas where the walking surface is flush with the track, consideration should be given to ensure that wherever possible, pedestrians are deflected away from the front of a tram rather than being drawn into the gap between the tram body and the track. The outside of the trams should be designed to deflect pedestrians away from the path of the tram wherever possible.

36) The risk assessment should identify a means of preventing pedestrians from either being crushed between the highway surface and the tram underfloor, or from going under the tram wheels at all areas identified in the assessment. For the purposes of this document, this is referred to as 'underrun protection'.

37) Fast moving protection systems such as 'drop down guards' should not be used as they may cause more harm than protection.

38) The gap between the highway surface and the underrun protection is dependent upon the tram layout and geometry in relation to the alignment. This should be considered when the scheme is being designed, including the procurement of tram vehicles.

39) The presence of vertical curves may result in an unavoidable large gap between the body and the track at the front of the tram. In situations where this occurs, pedestrians should be discouraged from being in the area of greatest risk. In these circumstances the hazard should be mitigated by other considerations such as, for example, reduced tram speed.

40) For underrun devices relating to heritage tramways refer to Appendix B.

Surfing

41) In order to prevent 'surfing' (the act of riding on the outside of a moving tram) the design of the tram and infrastructure in close proximity should avoid the possibility of providing accessible external hand-or foot-holds. Consideration should be given to surfing between coupled trams (whether in service or during recovery). Areas for particular attention include door rubbers and

step boards and anything on the rear of the tram that may offer a hand hold, for example, wipers, the intention to being to make it as difficult as possibly to obtain a hold.

Protruding Parts of The Tram Vehicle

42) The outside of the tram should minimise protrusions that could become entangled with pedestrian's clothing or cause injury.

Appendix F: Application of Highway Legislation to Tramways and Trams

1) Legislation within this appendix applies to England; there may be minor variations in relation to Scotland, Wales and Northern Ireland.

System Specification Legislation

2) It is unlawful to install or use tramway apparatus in, under or over a highway without appropriate authority (Highways Act 1980). Subject to minor exceptions, such authority has to be secured by or under statute.

3) Until 1993 this was obtained by means of a local Act of Parliament or by a Light Railway Order. Since 1993, the prescribed method of securing statutory authority has been by a TWA Order granted by the SoS under Part I of the Transport and Works Act 1992 and by a TAWS in Scotland since 2008 the Transport and Works (Scotland) Act 2007.

4) Based on the Transport and Works (Model Clauses for Railways and Tramways) Order 2006[82], TWA and TAWS Orders usually incorporate the following Powers to authorise tramway promoters and operators to (not exclusively):

- Install rails in the street and to specify their relationship to adjacent highway surfaces;
- Change alignments or substitute different trackwork;
- Construct and maintain works to control traffic on the tramway;
- Alter the position of utilities' apparatus;
- Alter the layout of streets, stop up streets, install level crossings and attach overhead supports to buildings;
- Remove obstructions from the tramway;
- Remove rails in the street in the case of discontinuance of the tramway; and
- Restore the highway surface and to safeguard the rights of highway authorities to widen, divert or improve any highway along which the tramway is laid.

5) Article 45 of the Model Clauses authorises a tramway operator to make byelaws that require confirmation by the SoS. Such byelaws include (not exclusively):

- Regulating the use and operation of, and travel on, its tramway;
- The maintenance of order on the tramway and its trams; and
- The removal of obstructions (including highway vehicles without drivers) from the path of the tramway.

Street Works Legislation

Overhead Electrical Equipment (OLE)

6) The consent of the SoS is required under Section 37 of the Electricity Act 1989[83] for the installation and maintenance of electric lines above the highway, but such consent is not needed if the lines

82 Transport and Works (Model Clauses for Railways and Tramways) Order 2006: http://www.legislation.gov.uk/uksi/2006/1954/made

83 The Electricity Act 1989: https://www.legislation.gov.uk/ukpga/1989/29/contents

are part of the apparatus of a tramway installed under statutory authority (Overhead Lines (Exemption) Regulations 1992[84].

7) Where an overhead electric line is located over a highway, the minimum height of such line is prescribed by the Electricity Safety, Quality and Continuity Regulations 2002, with variations allowable in specific circumstances. Where such height requirements cannot be met, (for example in the case of a low bridge), an exemption is required from the SoS.

Other Street Works

8) Powers relating to utilities are contained within a TWA or TAWS Order or other statue. Without statutory authority, tramway apparatus may only be placed or maintained in a street if a street works licence has been obtained from the relevant street authority (which includes local Highway Authorities) pursuant to sections 49 and 50 of the NRSWA 1991.

9) If works intended to be carried out by a tramway promoter or operator constitute major transport works, whether under statutory authority or not, there is an obligation on the part of the promoter / operator to agree the following (not exclusively) with statutory undertakers (utility owners / companies) (refer to Section 84 of NRSWA):

- The measures needed to be undertaken;
- The bodies to carry them out; and
- The manner in which they are to be co-ordinated.

10) The relevant costs are to be apportioned between the tramway operator and the other statutory undertakers involved in prescribed proportions as defined in the Street Works (Sharing of Costs of Works) Regulations 2000[85].

11) A street containing tramway apparatus may be designated by the relevant street authority as a street with special engineering difficulties. Tramway and other statutory undertakers operating in such streets may be required to work together to settle plans and the sections of works to be executed within them (refer to Section 63 of NRSWA).

12) Statutory undertakers proposing to execute street works that affect a tramway shall give notice of their intentions to the tramway promoter / operator. A statutory undertaker carrying out such works shall comply with any reasonable requirements made by tramway promoter / operator for securing the safety of people employed in connection with the works and ensuring that interference with the operation of the tramway by the works is kept to a minimum. The tramway promoter / operator is to be allowed reasonable time to formulate its requirements or make the necessary traffic arrangements.

13) These provisions do not affect the rights of statutory undertakers to carry out emergency works, but notice of their intention to do so shall be given to the tramway operator as soon as reasonably practicable (Section 93 of NRSWA).

84 The Overhead Lines (Exemption) Regulations 1992: http://www.legislation.gov.uk/uksi/1992/3074/contents/made

85 The Street Works (Sharing of Costs of Works) Regulations 2000: http://www.legislation.gov.uk/uksi/1992/1690/contents/made

Crossings of Tramways

14) The Highways Act 1980 allows Highway Authorities or the SoS to make Orders to extinguish or divert public rights of way that cross tramways. A tramway operator may apply for such an Order to be made (Sections 118A and 119A of the Act).

15) An undertaker carrying out street works in a street which crosses a tramway at grade, or which otherwise affect a tramway shall comply with the reasonable requirements of the promoter / operator of the tramway. They shall display any lights so as to avoid risk of confusion with any tramway signal lights or which might otherwise cause hindrance to the operation of the tramway (Section 92 of NRSWA).

New or Altered Works

16) ROGS 2006 as amended provides that no new or altered works to a tramway which would create or increase significant risk to safety are to be carried out by the promoter or operator of the tramway without such works having first been verified in a prescribed manner by a competent person. In so far as the works relate to the tramway infrastructure for which the relevant Highway Authority is wholly or partly responsible, it is for that Authority to establish the verification to the extent to which it has that responsibility, and to appoint the competent person to undertake the verification.

Road Traffic Legislation

Highway Act 1835

17) Trams are carriages for the purposes of Section 78 of this Act and so shall keep to the left, or near side, of any highway in which their rails are laid. This requirement may be overridden by appropriate statutory authority within a TWA or TAWS Order (for example, where a single-line of tramway is authorised to be operated in both directions, notwithstanding that the track is located in the centre or to one side of the highway). Such authority also generally allows for the reversal of trams at suitable points, where this is an inherent feature of their operation.

18) 'Wrong-line' running (a tram going the wrong direction against its prescribed direction in an emergency situation, as opposed to reversing that is for a short section) may be employed in emergencies, although it would obviously be advisable to liaise with the police authority if this were to be other than in isolated instances.

19) Special care and diligence shall be exercised in the case of tram movements that are contrary to left-hand running.

Public Passenger Vehicles Act 1981

20) Trams are not public passenger vehicles so in general the Public Passenger Vehicles Act 1981 does not apply. However, some of its provisions have been applied by local legislation and the SoS has power (though not so far exercised) to apply certain provisions to regulate the following:

- Conduct of inspectors, drivers and conductors;
- Conduct of passengers;
- Carriage of luggage and goods; and

- Safe custody and re-delivery of lost property

21) This Act generally applies to trams, but by virtue of the Tramcars and Trolley Vehicles (Modification of Enactments) Regulations 1992 (the Modification Regulations), they are exempt from the following provisions of the RTRA (relevant section of the RTRA in brackets).

- Traffic Regulation Orders (TROs) (Section 1);
- Equivalent orders within Greater London (Section 6);
- Experimental Traffic Orders (Section 9); and
- Orders relating to one-way traffic on trunk highways (Section 18).

22) The Modification Regulations also exempt trams from the effect of Orders or notices imposing temporary prohibitions or restrictions on certain highways (Section 14 of RTRA).

23) Under article 40(5) of the TWA Model Clauses referred to above, trams are to be regarded as public service vehicles for the purposes of the duty imposed on local authorities by Section 122(2)(c) of RTRA, to facilitate the passage of public service vehicles and securing the safety and convenience of their users.

24) The TSRGD have been made under this Act, as well as the Road Traffic Act 1988.

Road Traffic Act 1988 (RTA)

25) This Act applies generally to trams, but the following provisions of the Act do not apply by virtue of the Modification Regulations.

- Using a vehicle in a dangerous condition or for a dangerous purpose (Section 40A);
- Inspection of public passenger vehicles and goods vehicles (Section 68);
- Prohibition of unfit vehicles (Sections 69 to 73);
- Vehicles not to be sold in unroadworthy condition or as altered so as to be unroadworthy (Section 75);
- Fitting and supply of defective or unsuitable vehicle parts (Section 76);
- Testing condition of used vehicles at sale rooms or other premises (Section 77);
- Weighing of motor vehicles (Sections 78 and 79);
- Offences to do with reflectors and tail lamps (Section 83);
- Method of calculating weight of motor vehicles and trailers (Section 190); and
- Interpretation of statutory references to carriages (Section 191).

26) The Modification Regulations also extend Section 87 of RTA to make it necessary for the driver of a tram to possess a driving licence that authorises them to drive a motor vehicle in category B, within the meaning of the Motor Vehicles (Driving Licences) Regulations 1999[86], with a saving for people who were already driving trams during the year prior to 1 July 1992.

86 The Motor Vehicles (Driving Licences) Regulations 1999: https://www.legislation.gov.uk/uksi/1999/2864/contents

27) The Modification Regulations also exempt trams from the following subsidiary legislation made under the RTA:

- Motor Vehicles (Test) Regulations 1981[87], which require the construction and condition of motor vehicles to be examined and for a test certificate to be issued on compliance,
- Road Vehicles (Construction and Use) Regulations 1986, which impose general requirements governing the use of motor vehicles, their condition and equipment and the conditions under which they may be used, and
- Road Vehicles Lighting Regulations 1989 (as amended), which impose requirements as to the lighting of motor vehicles.

Road Traffic Offenders Act 1988

28) The Road Traffic Offenders Act 1988[88] Act generally applies to trams, but power is conferred on the SoS to disapply certain of its provisions (though not so far exercised), for example, requiring warning of prosecution etc., and provisions concerning driving licences etc.

Transport and Works Act 1992 (TWA)

29) Part II of this Act makes it a criminal offence for inspectors, drivers and conductors of trams and their supervisors to be unfit to carry out their duties through alcoholic drink or drugs or after consuming so much alcohol that the proportion of it in the person's breath, blood or urine exceeds an amount prescribed by the Act. Refer to LRG 33.0 Guidance on the Management of Drugs and Alcohol for more information

30) There are also detailed supplementary provisions, most of which are analogous to the equivalent provisions for highway vehicles contained in Sections 4 to 11 of the RTA.

Traffic Signs, Signals and Barriers Legislation

Transport and Works Act (TWA) and Transport and Works (Scotland) Act (TAWS) Orders

31) A TWA or TAWS Order enables a tramway operator to place or permit the placing of crossing signs and barriers on or near a private road or path near a tramway crossing.

32) The SoS may give directions to the tramway operator as to the placing of such signs or barriers (Sections 52 to 54 of TWA).

33) The nature of the signs and barriers are prescribed in the Private Crossings (Signs and Barriers) Regulations 1996[89].

Traffic Signs Regulations and General Directions 2016 (TSRGD)

34) These regulations and directions are made under RTRA and RTA and prescribe the highway traffic signals and signs required for a tramway. Any deviation from the TSRGD shall be obtained from the

87 The Motor Vehicles (Tests) Regulations 1981: https://www.legislation.gov.uk/uksi/1981/1694/contents
88 Road Traffic Offenders Act 1988: https://www.legislation.gov.uk/ukpga/1988/53/contents
89 The Private Crossings (Signs and Barriers) Regulations 1996: https://www.legislation.gov.uk/uksi/1996/1786/contents/made

SoS (or their agents) These regulations and directions are made under RTRA and RTA and prescribe the highway traffic signals and signs required for a tramway. Any deviation from the TSRGD shall be obtained from the SoS (or their agents).

Appendix G: Tramway Clearances

This appendix provides guidance on tramway clearances, to be read alongside the text in Section 3 of the main document and is in line with UK good practice.

Figure App G.1: Clearances Between Tram and Cycle Lane

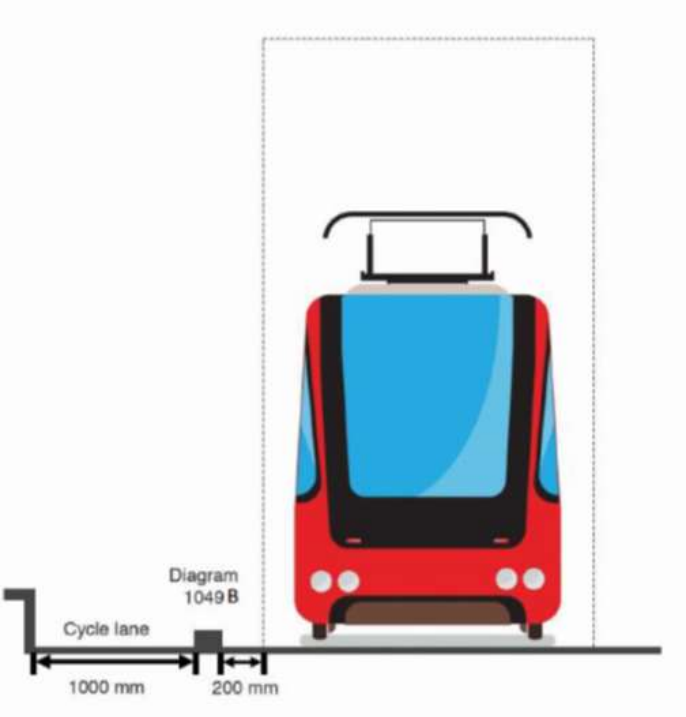


Figure App G.2: Clearances in Pedestrian Only Areas

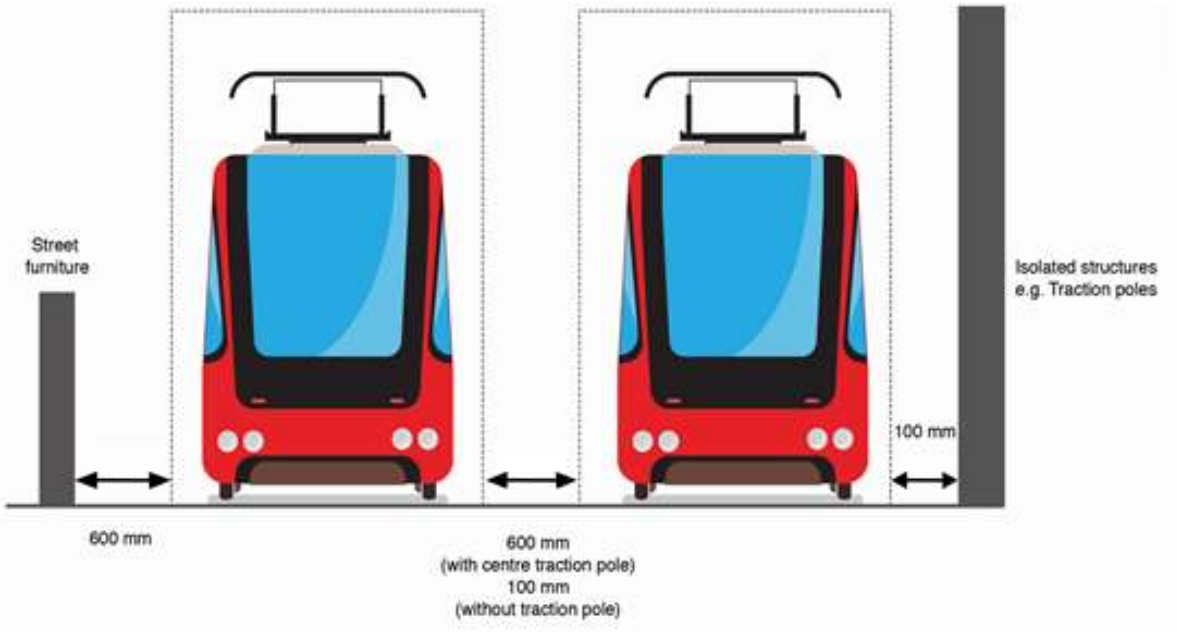


Figure App G.3: Clearances in Carriageway with Shared Lanes

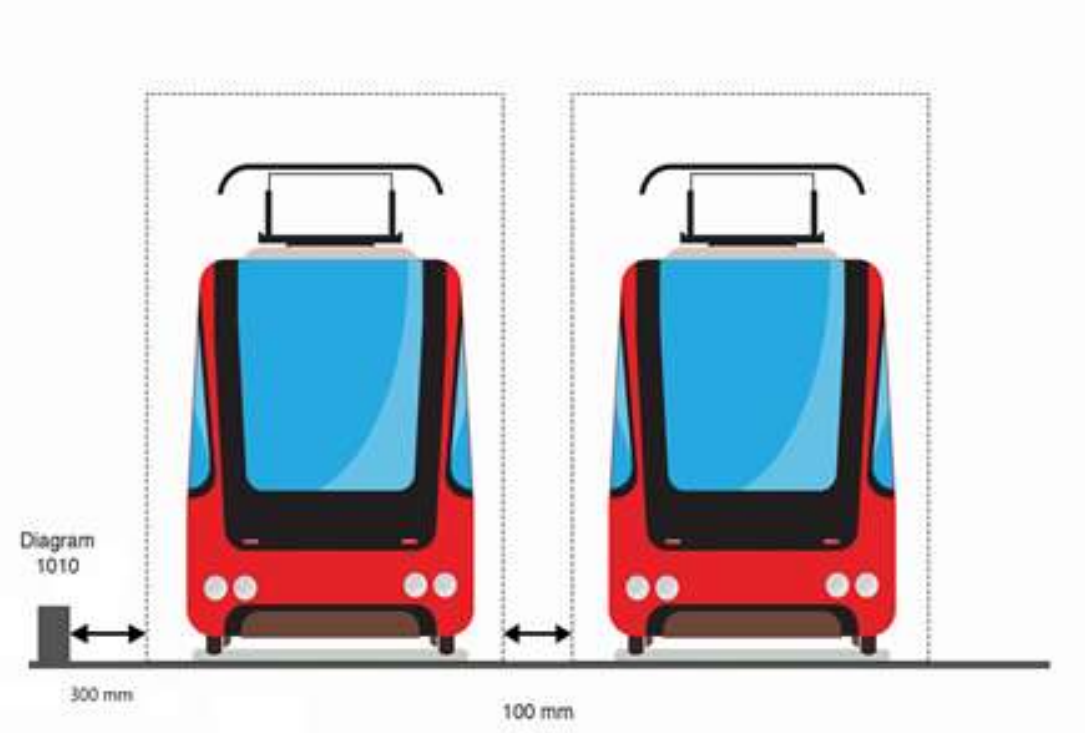


Figure App G.4: Clearances on Reserved Sections of Carriageway

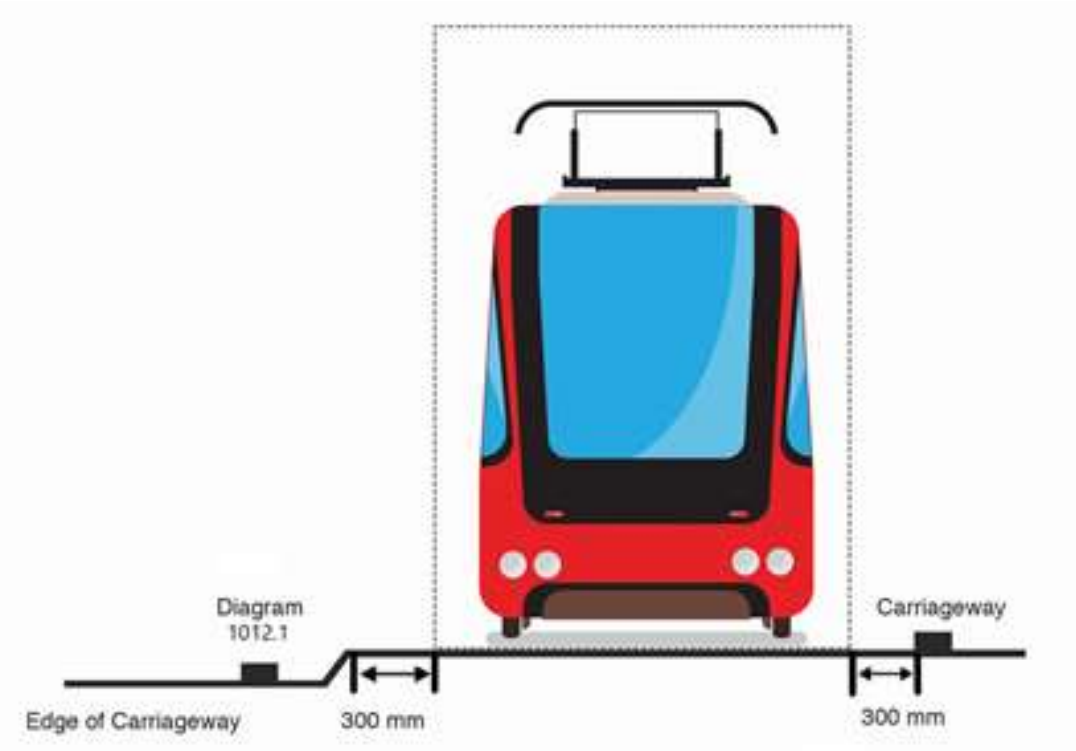


Figure App G.5: Clearances to Traction Poles

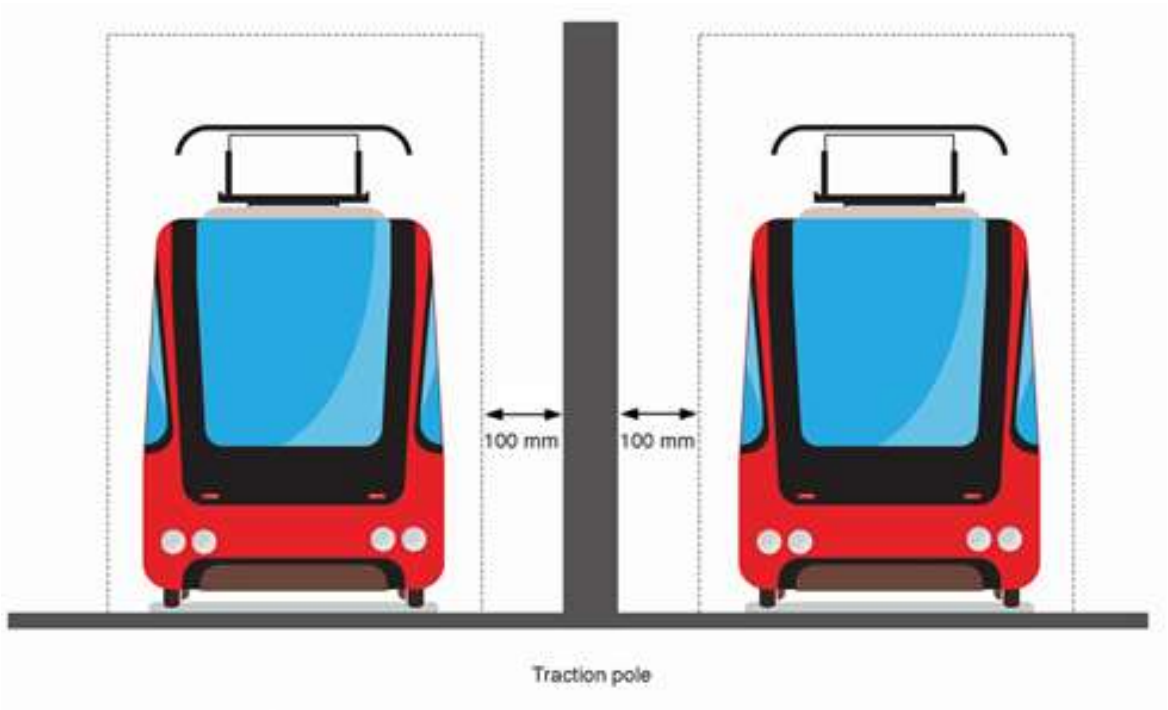


Figure App G.6: Clearances to Electric Traction Poles on a Footway

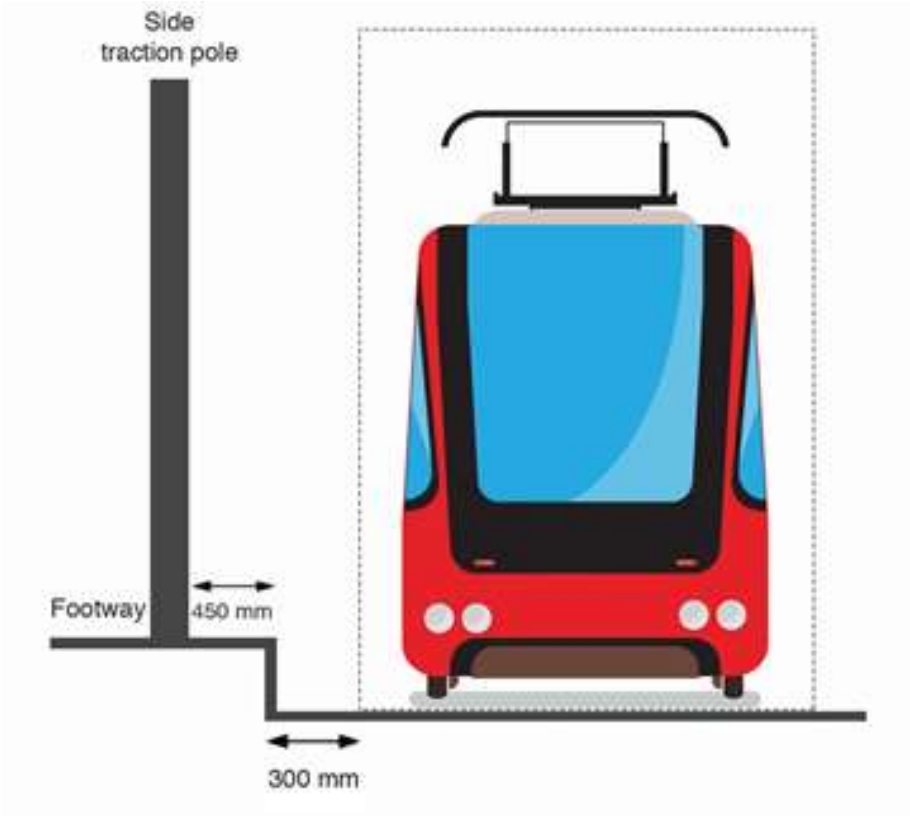
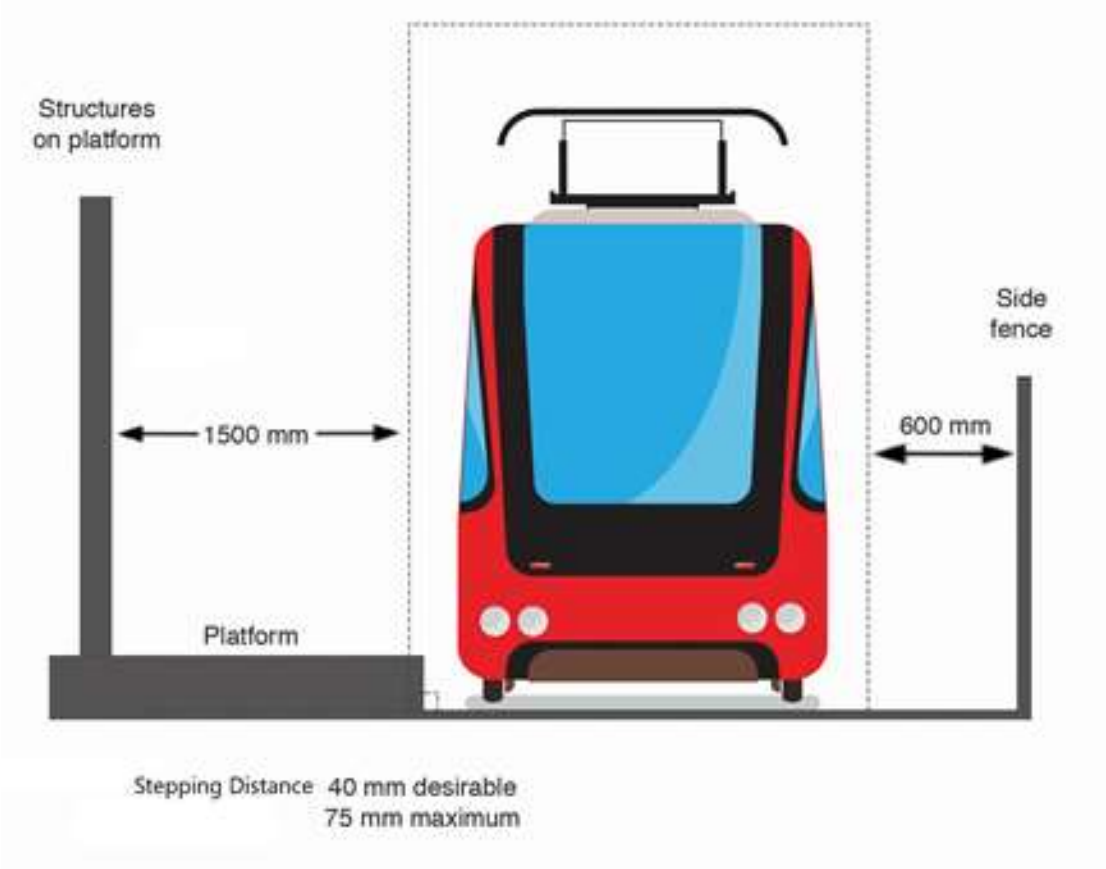


Figure App G.7: Clearances at Tramstops and Fences



Appendix H: References

1) In all cases where reference is made to legislation, readers should check for any amendments that have subsequently been made to the text of that legislation. All links provided within this document are correct at the time of publication.

2) Much of this regulation derives from directives of the European Union (EU), and these in turn derive largely from United Nations Economic Commission for Europe (UNECE) regulations and are globally agreed standards. The UK withdrawal from the EU has not affected the content or locus of the UK regulations.

3) The majority of HSE publications can be downloaded free of charge from the website http://books.hse.gov.uk.

4) The Stationery Office publications are available from www.tso.co.uk.

5) The majority of UK Public legislation is available as free downloads from the UK Government's legislation website www.legislation.gov.uk.

6) Table App H.1 below lists all legislation referred to in this document (including appendices) in alphabetical order.

Table App H.1: Alphabetical List of Legislation and Guidance Etc Referred to in LRG 1.0

Reference Number	Document
71	Confidential safety hotline for the transport sector https://www.ciras.org.uk/
2	Construction (Design and Management) Regulations 2015 https://www.legislation.gov.uk/uksi/2015/51/introduction
27	Design Manual for Roads and Bridges https://www.standardsforhighways.co.uk/dmrb
83	The Electricity Act 1989 https://www.legislation.gov.uk/ukpga/1989/29/contents
38	Electricity at Work Regulations 1989 https://www.legislation.gov.uk/uksi/1989/635/contents
20 and 45	Electricity Safety, Quality and Continuity Regulations 2002 https://www.legislation.gov.uk/uksi/2002/2665/contents
74	The Fire and Safety (Scotland) Regulations 2006 https://www.legislation.gov.uk/ssi/2006/456/contents
75	Fire Safety Risk Assessment: Transport Premises and Facilities https://www.gov.uk/government/publications/fire-safety-risk-assessment-transport-premises-and-facilities
73	Fire (Scotland) Act 2005: https://www.legislation.gov.uk/asp/2005/5/contents

Reference Number	Document
31	GG 119 Road Safety Audit https://www.standardsforhighways.co.uk/search/710d4c33-0032-4dfb-8303-17aff1ce804b
30	Guidance on the use of tactile paving (2021) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1046126/guidance-on-the-use-of-tactile-paving-surfaces.pdf
66	Health and Safety at Work Act 1974 https://www.legislation.gov.uk/ukpga/1974/37/contents
9	The Health and Safety (Enforcing Authorities for Railways and Other Guided Transport Systems) Regulations 2006 https://www.legislation.gov.uk/uksi/2006/557
46	Highway Act 1835 http://www.legislation.gov.uk/ukpga/Will4/5-6/50/contents
25	The Highway Code https://www.gov.uk/guidance/the-highway-code
22	Highways Act 1980 http://www.legislation.gov.uk/ukpga/1980/66/contents
26	The Level Crossings Act 1983 https://www.legislation.gov.uk/ukpga/1983/16/contents
1	LRSSB https://resources.lrssb.org/
67	The Management of Health and Safety at Work Regulations 1999 https://www.legislation.gov.uk/uksi/1999/3242/contents
28	Manual for Streets, Department for Transport 2007 https://www.gov.uk/government/publications/manual-for-streets
86	The Motor Vehicles (Driving Licences) Regulations 1999 https://www.legislation.gov.uk/uksi/1999/2864/contents
87	The Motor Vehicles (Tests) Regulations 1981 https://www.legislation.gov.uk/uksi/1981/1694/contents
15	New Roads and Street Works Act 1991 http://www.legislation.gov.uk/ukpga/1991/22/contents
16	New Roads and Street Works Act 1991 (Commencement No 1) (Scotland) Order 1991 https://www.legislation.gov.uk/uksi/1991/2286/contents/made#:~:text=This%20Order%20brings%20into%20force%E2%80%94on%2021st%20October%201991%2C,and%20Schedules%208%20and%209%20to%2C%20the%20Act.
84	The Overhead Lines (Exemption) Regulations 1992 http://www.legislation.gov.uk/uksi/1992/3074/contents/made
65	Overturning of a tram at Sandilands junction, Croydon (v2.2 -–October 2020) https://assets.publishing.service.gov.uk/media/5de79643e5274a06dee23a10/R182017_201022_Sandilands_v2.2.pdf

Reference Number	Document
76	Practical Fire Safety Guidance for Existing Non-residential Premises https://www.gov.scot/publications/practical-fire-safety-guidance-existing-non-residential-premises-9781788511322/
89	The Private Crossings (Signs and Barriers) Regulations 1996 https://www.legislation.gov.uk/uksi/1996/1786/contents/made
10	Public Passenger Vehicles Act 1981 https://www.legislation.gov.uk/ukpga/1981/14
19	The Rail Vehicle Accessibility (Non-Interoperable Rail System) Regulations 2010 https://www.legislation.gov.uk/uksi/2010/432/contents
5 and 6	The Railways and Other Guided Transport Systems (Safety) Regulations 2006 (as amended) https://www.legislation.gov.uk/uksi/2006/599/contents
72	Regulatory Reform (Fire Safety) Order 2005 https://www.legislation.gov.uk/uksi/2005/1541/contents
70	The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 https://www.legislation.gov.uk/uksi/2013/1471/contents
13	Road Traffic Act 1988 http://www.legislation.gov.uk/ukpga/1988/52/contents
88	Road Traffic Offenders Act 1988 https://www.legislation.gov.uk/ukpga/1988/53/contents
12	Road Traffic Regulation Act 1984 http://www.legislation.gov.uk/ukpga/1984/27/contents
14	The Road Vehicles (Construction and Use) Regulations 1986 https://www.legislation.gov.uk/uksi/1986/1078/contents
24	Road Vehicle (Construction and Use) (Amendment) (No.6) Regulations 1995 http://www.legislation.gov.uk/uksi/1995/3051/contents/made
48	Road Vehicle Lighting Regulations 1989 https://www.legislation.gov.uk/uksi/1989/1796/contents
23	Roads (Scotland) Act 1984 http://www.legislation.gov.uk/ukpga/1984/54/contents
69	Safeguarding Adults, Patient https://patient.info/doctor/safeguarding-adults-pro
17	Safety at Street Works and Road Works: A Code of Practice https://www.gov.uk/government/publications/safety-at-street-works-and-road-works
7	Strategy for regulation of health and safety risks - chapter 1: Health & Safety Management Systems https://www.orr.gov.uk/sites/default/files/om/safety-strategy-chapter-1.pdf#:~:text=An%20SMS%20is%20more%20than%20a%20written%20policy,managed%20to%20deliver%20effective%20and%20efficient%20risk%20control.

Reference Number	Document
85	The Street Works (Sharing of Costs of Works) Regulations 2000 http://www.legislation.gov.uk/uksi/1992/1690/contents/made
18	The Traffic Signs Manual https://www.gov.uk/government/publications/traffic-signs-manual
21	Traffic Signs Regulations and General Directions 2016 http://www.legislation.gov.uk/uksi/2016/362/contents
11	Tramcars and Trolley Vehicles (Modification of Enactments) Regulations 1992 http://www.legislation.gov.uk/uksi/1992/1217/contents/made
3	Transport and Works Act 1992 http://www.legislation.gov.uk/ukpga/1992/42/contents
82	Transport and Works (Model Clauses for Railways and Tramways) Order 2006 http://www.legislation.gov.uk/uksi/2006/1954/made
4	Transport and Works (Scotland) Act 2007 (asp.8) https://www.legislation.gov.uk/asp/2007/8/contents
47	Vehicle Certification Agency website: https://www.vehicle-certification-agency.gov.uk/
68	Working Time (Amendment) Regulations 2003 https://www.legislation.gov.uk/uksi/2003/1684/contents/made

References to Standards and EC Directives

7) Table App H.2 below lists all standards and EC directives (etc) etc referred to in this document (including appendices) in alphabetical / numerical order.

Table App H.2: Alphabetical / Numerical List of Standards Referred to in LRG 1.0

Reference Number	Document
49	76/756/EEC: The approximation of the laws of the Member States relating to the installation of lighting and light-signalling devices on motor vehicles and their trailers
36	BS 5489-1:2020 - Design of road lighting. Lighting of roads and public amenity areas. Code of practice
77	BS 9999:2017 Code of practice for fire safety in the design, management and use of buildings https://knowledge.bsigroup.com/products/fire-safety-in-the-design-management-and-use-of-buildings-code-of-practice/tracked-changes
35	BS EN 1991-2:2023 Eurocode 1. Actions on structures. Traffic loads on bridges and other civil engineering works
56	BS EN 12663-1:2010+A2:2023 Railway applications. Structural requirements of railway vehicle bodies. Locomotives and passenger rolling stock (and alternative method for freight wagons)
52 and 61	BS EN 13272 Railway applications - Electrical lighting for rolling stock in public transport systems
60	BS EN 13452:2003 – Railway applications – Braking – Mass transit brake systems
33	BS EN 13674- 1:2011+A1:2017 Railway applications. Track. Rail. Vignole railway rails 46 kg/m and above
62	BS EN 14752:2019+A1:2020: Railway applications. Body entrance systems
32	BS EN 14811:2019 Railway applications. Track. Special purpose rail. Grooved rails and associated construction profiles
55	BS EN 15153-4:2020 Railway applications - External visible and audible warning devices - Part 4: Audible warning devices for urban rail
57	BS EN 15227:2020: Railway applications. Crashworthiness requirements for railway vehicle bodies
81	BS EN 15746-4:2020 Railway applications. Track. Road-rail machines and associated equipment - Technical requirements for running, travelling and working on urban rail
29	BS EN 16186-5:2021+A1:2023 Railway applications. Driver's cabs - External visibility for tram vehicles
58	BS EN 16186-8:2022 Railway applications. Driver's cab - Part 8: Tram vehicle layout and access
34	BS EN 17636:2023 Rail applications. Infrastructure. Track Alignment Design parameters. Urban rail

Reference Number	Document
63	BS EN 45545-2:2020+A1:2023 Railway applications. Fire protection on railway vehicles. Requirements for fire behaviour of materials and components
43	BS EN 50119:2020 Railway applications. Fixed installations. Electric traction overhead contact lines
44	BS EN 50121-1: 2017 Railway applications. Electromagnetic compatibility. General
40 and 42	BS EN 50122: 2022 Railway applications. Fixed installations. Electrical safety, earthing and the return circuit Protective provisions against electric shock
41	BS EN 50345:2009 Railway applications. Fixed installations. Electric traction. Insulating synthetic rope assemblies for support of overhead contact lines'
59	DIN 5566-3+A1:2023-12 Railway vehicles - Driver cabs - Part 3: Additional requirements for urban and suburban rolling stock
8	EN 17343: 2023 Railway Application - General Terms and Definitions
53	EN 45545-1:2013: Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behaviour of materials and components
37	EN 50163:2004+A2:2020 Railway applications - Supply voltages of traction systems
64	EN 50206-2: 2010: Railway applications. Rolling stock. Pantographs: characteristics and tests. Pantographs for metros and light rail vehicles
39	IEC 60913:2013 Railway applications – Fixed installations – Electric traction overhead contact lines
80	TOPAS 0600E: A Self-Certification Procedures for Statutory Approval of Traffic Control Equipment https://topasgroup.org.uk/media/Topas-0600E-Final_1.pdf
78	TOPAS document 2500B Specification for traffic signal controller https://topasgroup.org.uk/media/TOPAS-2500B.pdf
79	TOPAS 2514B: Tram Signals https://topasgroup.org.uk
54	UNECE Regulation 46 Devices for indirect vision and motor vehicles with regard to the installation of these devices
51	UNECE Regulation 48: Uniform provisions concerning the approval of vehicles with regard to the installation of lighting and light-signalling devices.
50	UNECE Regulation 113: Uniform provisions concerning the approval of motor vehicle headlamps emitting a symmetrical passing beam or a driving beam or both and equipped with filament, gas-discharge light sources or LED modules