



LONDON BUS SERVICES LIMITED

Specification for New Buses

Version 2.4

Issued March 2023

Effective from Tranche 872



Preface

This specification will determine the technical characteristics required for all new London buses.

Where an Original Equipment Manufacturer (OEM) perceives that a particular feature of this document should be changed, this should be raised by the OEM with the Approval Authority (London Bus Service Limited - LBSL) assessor present at the assessment, or in writing to the Approval Authority (LBSL) Nominated Officer in the absence of an assessor. The competent authority (LBSL) will assess the proposal based on their judgment and provide instruction to the assessment facility.

OEMs are directly or indirectly barred from interfering with any assessment undertaken as part of this specification and prohibited from altering any characteristics that may impact the assessment, including but not restricted to vehicle setting, laboratory environment etc.

Version	Publisher	Date	Details
2.4	TfL	March 2023	LBSL Bus Specification

Disclaimer

LBSL has taken all appropriate caution to guarantee that the information contained in this protocol is correct and demonstrates the prevailing technical decisions taken by the organisation. In the occasion that a mistake or inaccuracy is identified, LBSL retains the right to make amendments and decide on the assessment and future outcome of the affected requirement(s).

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Version Control

Revision Date	Tranche Implementation Date	Revision No	Page No	Section	Summary of changes
Dec 18	670	1.0			Issued
May 19	670	1.1	7	3 Regulatory Compliance	Clarifications of certification, text added regarding types and variants.
			22	4.3.3 Intelligent Speed Assistance (ISA)	Clarification of map updating, definition of warning Human Machine Interface (HMI) and symbol.
			27	4.3.4.2 Camera Monitor System (CMS): Reversing	Clarification of certification and about Reg 46.
			32	4.3.5.2 Accelerator Light	Clarification of activation levels, and auditory warning.
			34	4.3.5.3 Brake toggle system	Clarification of certification, and failure warning.
			35	4.3.5.4 Pedal acoustic feedback system	Description of goals added.
			37	4.3.6 Runaway Bus Prevention	Driver input and maintenance requirements clarified.
			40	4.3.7 Halt Brake	Moved to separate section, maintenance checks added.
			43	4.4.1 Acoustic Conspicuity	Requirements on hybrid vehicle added, notes about developments, diagrams showing speaker location, and update details added.
			49	4.5.6 Flooring and Slip prevention	Requirements for new materials added.
			54	4.6.4 VRU Frontal Crashworthiness: Wiper Protection	Wipers defined in relation to bus dimensions.
			61	6.1 Vehicle capacity	Clarification of non-conforming vehicle dimensions, and wipers in relation to dimensions.
			73	8.3 Heating, Ventilation & Air Conditioning (HVAC)	Clarifications made.



				All attachments relevant to above	Updated to reflect changes to the spec.
Jul 20	734	2.0	2	1.4 Terminology	Structure updated; text added to clarify document scope.
			4 to 7	2 Status of Application Requirements	Corrections made to subsection descriptors and timings.
			13	Section 4.2.1 Protecting the driver from Assault	Driver Assault screen specification updated to included pathogen protection
			13	4.3.1 Acceleration performance	Lower maximum acceleration limit removed.
			14 to 18	4.3.3 Intelligent Speed Assistance (ISA)	Text added to operating modes and performance requirements (Restricted Operating Mode (ROM), Option types, ROM activation time, Speed Limit indicator requirements).
			21 to 23	4.3.4.4 Camera Monitor System (CMS): Mirror Replacement	Text added – HMI performance requirements defined.
			24	4.3.5 Pedal Application error	Text added – Guidance as to current status of safety feature.
			25 to 28	4.3.5.2 Accelerator Light System (ALS)	Accelerator Light symbol and HMI requirements defined.
			29	4.3.5.3 Brake Toggle System	Text added to clarify performance requirements and further work.
			31	4.3.7 Halt Brake	Text added to better define performance requirements.
			31 to 34	4.4.1 Acoustic Conspicuity	Text added to better define performance requirements.
			37 to 38	4.5.6 Flooring and Slip Prevention	Text added to better define performance and certification requirements.
			42	4.5.7 Door Safety	Door/ramp interlock safety logic requirement added
			40 to 41	4.6.1 VRU Frontal Crashworthiness: Minimum Geometry	Corrections and clarifications made to performance and assessment requirements.
			41 to 42	4.6.2 VRU Frontal Crashworthiness: Enhanced Geometry	Updates made to performance and assessment requirements.
			42	4.6.3 VRU Frontal Crashworthiness: Energy	Minimum HIC ₁₅ value updated to 1350



				Absorption	
			53	6.2 Energy Efficiency - Electric Vehicles	Charger connection type standard updated
			58	8.3 Heating, Ventilation & Air Conditioning (HVAC)	Updated to separate driver cab Air-conditioning system from rest of vehicle. Evidence required in line with Attachment 9.
			63	10.3 Other internal and external signs and notices	Updated to link to latest version of the London Buses- Bus Graphics Standard
				Attachment 7: Wheelchair Floor Logo	Logo position and dimension tolerances updated.
				Attachment 8: Handrail requirements	Positional dimension tolerance updated.
				Attachment 9: HVAC Assessment Protocol	Test procedure updated. Pre-test design evidence requirement added.
				Attachment 17: ISA Assessment Protocol	Test requirements and procedures updated in line with specification updates.
				Attachment 18: ISA Guidance Notes	Aftermarket equipment requirements updated.
				Attachment 19: Bus Vision Standard Assessment Protocol	Ocular assessment point changed from Ambinocular to monocular. Assessment protocol requirements updated.
				Attachment 20: Bus Vision Standard Guidance notes	Language and consistency updates.
				Attachment 21: Blind spot Mirror Guidance Notes	Language and consistency updates.
				Attachment 22: CMS Mirror replacement Guidance Notes	Language and consistency updates.
				Attachment 23: Rear-view CMS Guidance Notes	Language and consistency updates.
				Attachment 24: Blind Spot Warning Assessment Protocol	Test scenarios and procedures updated.



				Attachment 26: Pedal Application Error Assessment Protocol	Test procedures updated in line with specification updates.
				Attachment 28: Runaway Bus Assessment Protocol	Test scenarios and procedures updated.
				Attachment 29: Runaway Bus Guidance Notes	Language and consistency updates.
				Attachment 30: Acoustic Conspicuity Assessment Protocol	Test procedures updated in line with specification updates.
				Attachment 31: Acoustic Conspicuity Guidance Notes	Language and consistency updates.
				Attachment 32: Slip Protection Assessment Protocol	Test scenarios and procedures updated in line with specification updates.
				Attachment 33: Slip Protection Guidance Notes	Test scenarios and procedures updated in line with specification updates.
				Attachment 34: Occupant Friendly Interiors Assessment Protocol	Test zone updated.
				Attachment 36: Bus Impact Test Standard Assessment Protocol	Minimum HIC ₁₅ value updated to 1350
				Attachment 38: VCW – Minimum Geometry Guidance Notes	Test areas and procedures updated in line with specification updates.
				Attachment 39: VCW – Enhanced Geometry Assessment Protocol	Test areas and procedures updated in line with specification updates.
				Attachment 40: VCW – Enhanced Geometry Guidance Notes	Test areas and procedures updated in line with specification updates.
				Attachment 41: Wiper Protection Guidance Notes	Attachment number updated.



Dec 2020		2.1	1	1.1 Scope	Removal of reference to Class II vehicles – All relevant Attachments updated to reflect this
			3 to 6	2 Status of application of requirements	Table updated to reflect changes in research work packages (Pedal Confusion)
			8	3.1 Regulatory Compliance	Clarification as to cost responsibility for parties
			20	4.3.4.3 Direct Vision Score (DVS) and Enhanced total Bus Vision Score (BVS)	Vision Score requirements updated to reflect changes to assessment protocol (see Attachment 19 for full details)
			30 to 34	4.4.1 Acoustic Conspicuity	Correction to maximum applicable speed (pg 32), updates to requirements
			42	4.6.4 VRU Frontal Crashworthiness: Wiper Protection	Update to required HIC ₁₅ requirements for new and existing bus models
			46	6.1 Vehicle Capacity	Table 6.1 updated to reflect changes to entrance and exit door width requirements
			47	6.3 Minimising Dwell time	Entrance and exit door width requirements updated
				Attachment 1: London Bus Cycle	Clarification to Reg. 101 applicability
				Attachment 3: Fleet Management Systems (FMS)	Updated with current FMS requirements
				Attachment 11: CCTV	Updated with current CCTV requirements
				Attachment 12: Exterior and Interior Notices	Updated to link in with relevant BVS section within this document (section 10)
				Attachment 14: Free Issued Equipment	Updated with current Free Issued Equipment requirements
				Attachment 17: Intelligent Speed Assistance (ISA) Assessment Protocol	Updated to test requirement – 9.1.3.6.b
				Attachment 18: Intelligent Speed Assistance (ISA) Guidance Notes	ISA strategy requirements updated in line with those of BVS requirements (Section 4.3.3) and Attachment 17



				Attachment 26: Pedal Application Error Assessment Protocol	Test trac requiremetns updated, Appendix A updated to take Test Track gradient into account
				Attachment 30: Acoustic Conspicuity Assessment Protocol	Updated in line with changes made to Section 4.4.1 of BVS
				Attachment 31: Acoustic Conspicuity Guidance Notes	Updated in line with changes made to Section 4.4.1 of BVS and Attachment 30
				Attachment 41: Bus Front End Design – Wiper Protection Guidance Notes	Updated to reflect changes made to BVS section 4.6.4
Apr 2022	830	2.2	7	3.1 Regulatory and TfL Compliance	Amendment of R118 to Rev 03, inclusion of PSVAR2000 compliance requirements
			8 to 9	3.2 Test Process	Addition of Matrix of certification requirements
			18	4.3.3.3 Intelligent Speed Assistance	Amendment to speed limit display wording
			20	4.3.4.2 Camera Monitor System (CMS): Reversing	Amendment to mirror class definition
			31 to 35	4.4.1 Acoustic Conspicuity	Amended to include requirement of Responsive AVAS
				4.5.7(pg 38), 4.7(pg 43), 6.1(pg 46), 7(pg 53 & 54) and 8.4 (pg 63)	Amendment for General Assembly Drawing submission and approval process
			40	4.6.1 VRU Frontal Crashworthiness: Minimum Geometry	Correction to figure numberings
			58 to 62	8.3 Heating, Ventilation & Air Conditioning (HVAC)	Updated specification
				Attachment 5: Driver-Passenger 2 Way Intercom Systems	Updated Attachment
				Attachment 6: Standard for the Fire Retardant Properties of Materials	Amended to reflect requirement of Reg. 118 Rev 03 adherence



				Attachment 9: Heating Ventilation and Air Conditioning (HVAC)	Amended to reflect changes in BVS document (section 8.3)
				Attachment 11: CCTV	Updated current CCTV requirements
				Attachment 17: Intelligent Speed Assistance (ISA) Assessment Protocol	Amendment to weather condition requirements
				Attachment 19: Bus Vision Standard Assessment Protocol	Correction to referenced BVS section number
				Attachment 24: Blind Spot Warning (BSW) Assessment Protocol	Correction to referenced BVS section number
				Attachment 26: Pedal Application Error Assessment Protocol	Correction to referenced BVS section number
				Attachment 27: Pedal Application Error Guidance Notes	Amendment to Brake Toggling Task orders
				Attachment 28: Runaway Bus Prevention Assessment Protocol	Correction to referenced BVS section number
				Attachment 30: Acoustic Conspicuity Assessment Protocol	Amended to reflect changes in BVS document (section 4.4.1)
				Attachment 34: Occupant Friendly Interiors Assessment Protocol	Correction to referenced BVS section number
				Attachment 41: Bus Front End Design – Wiper Protection Guidance Notes	Correction to referenced BVS section number
Aug 2022	872	2.3	6	2 Status of Application of Requirements	Table 2_1 updated to reflect upcoming safety features
			9 to 10	3.2 Test Process	Matrix of certification updated and amended



			10	3.3.1 Type-, variant- and version designations	Table 2_2 updated to reflect upcoming safety features
			14 to 18	4.3.2 Advanced Emergency Braking (AEB)	Addition of subsections, amendments to True and False Positive requirements
			24	4.3.4.2 Camera Monitor System (CMS): Reversing	Amendment of applicable UNECE Regulation to 158
			35	4.3.8 Tyre Pressure Monitoring Systems (TPMS)	New section added, Tyre Pressure Monitoring Systems
			36	4.3.9 Alcohol Interlock Installation Facilitation	New section added, Alcohol Interlock Installation Facilitation
			41	4.5.3 handrail/stanchion construction and installation	Vertical handrail requirements updated
			58 to 62	8.3 Heating, Ventilation & Air Conditioning (HVAC)	Update to HVAC requirements
			72	10.3 Other internal and external signs and notices	Link to latest Bus Graphics Standard updated
			74	10.5 Paints colours and Livery	Link to latest Bus Graphics Standard updated
				Attachment 6: Standard for the Fire Retardant Properties of Materials	Definition of engine bay added, compliance requirements updated
				Attachment 9: Heating Ventilation and Air Conditioning (HVAC)	Updated test procedure to reflect changes to specification
				Attachment 15: Advanced Emergency Braking Assessment Protocol	Scoring and weighting amendments amended
				Attachment 16: Advanced Emergency Braking Guidance Notes	False Positive requirements updated
				Attachment 17: Intelligent Speed Assistance (ISA) Assessment	Amendment to section 9.1.3.3 b)



				Protocol	
				Attachment 34: Occupant Friendly Interiors Assessment Protocol	Normative references updated
				Attachment 42: Complex Eletronic Control Systems	New Attachment created to facilitate Attachments 15 & 16
Mar 2023	872	2.4	8	3.2.1 Testing and Certification Requirements	Definition of Test Service added
			9 to 12	3.2.2 Compliance Carryover Between Vehicle Types and Variants	Table 3_2 added, detailing evidence requirements when compliance carryover is intended
			15 to 16	4.1.1 Smoke Detectors	Update to smoke detector requirements, increase in quantity and scope of smoke detectors, Emergency Shutoff button scope and wording
			23 to 24	4.3.3 Intelligent Speed Assistance (ISA)	Updates to ISA symbol light colour requirements. Update to ISA system logic requirements through removal of 'Option 1' logic
			34 to 35	4.3.5.3 Brake toggle system	Update and clarification to system logic
			36 to 40	4.3.6 Runaway Bus Prevention	Changes to Runaway Bus Prevention system logic and performance requirements
			40	4.3.7 Halt Brake	Update to definition and clarification of functionality
			51	4.6.1 VRU Frontal Crashworthiness: Minimum Geometry	Clarifying wording added to use of 236 mm x 236 mm probe for measuring global geometry angles
			53	4.6.2 VRU Frontal Crashworthiness: Enhanced Geometry	Clarifying wording added to use of 236 mm x 236 mm probe for measuring global geometry angles
			55	4.7.1 Rescue Sheet & Emergency Rescue Guide (ERG)	Emergency rescue guide requirement added



			56	4.7.2	Rescue Sheet and ERG Storage	Rescue sheet and Emergency rescue guide requirements added
			59	5.2	Air quality and emissions	Vehicle Idle shutdown requirement scope updated to include EV buses
			73	8.3.1	Drivers Cab	Updates to HVAC performance requirements
			74	8.3.2	Passenger Saloon	Updates to HVAC cooling and heating and performance requirements
			79	8.3.3	HVAC Test Switch	Addition of a test switch for in service performance monitoring
			79	8.3.4	Thermal Insulation	Updates to HVAC insulation performance requirements
			35		Attachment 6	Update to RESS compliance level and timings
			117 to 137		Attachment 17	Inclusion of audible alert check, ISA status symbol colours and test procedure to reflect amendments to specification
			137 to 140		Attachment 18	Updated to to reflect amendments to specification and Attachment 17
			228 to 239		Attachment 26	Amendments to ALS test requirements and BTS requirements, including addition of a reverse gear test scenario
			239 to 246		Attachment 27	Amendments to guidance notes to reflect changes to assessment protocol and specification
			246 to 255		Attachment 28	Amendment to Runaway Bus Prevention assessment protocol to reflect changes to specification requirements
			255 to 258		Attachment 29	Amendments to guidance notes to reflect changes to assessment protocol and specification
			282 to 303		Attachment 34	Updated assessment protocol procedure for useability and clarity
			303 to 307		Attachment 35	Amendments to guidance notes to reflect changes to assessment protocol
			330		Attachment 37	Correction to lower impact speed
			356		Attachment 40	Guidance added regarding advised vehicle extension lengths



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1 Introduction

This document defines LBSL's technical requirements for new buses entering into service in London.

1.1 Scope

This protocol applies to all new buses intended for service under contract to LBSL that are passenger vehicles with a maximum mass exceeding 5 tonnes and a capacity exceeding 22 passengers. The passenger vehicles will be capable of carrying seated but unrestrained occupants and standing occupants. Such vehicles are categorised the Consolidated Resolution on the Construction of Vehicles (R.E.3) as M3; Class I.

1.2 Purpose

LBSL wishes to promote a world leading bus service in London. As such LBSL has a range of objectives and wishes for all new buses used in London to contribute to the achievement of those objectives:

- Regulatory Compliance
- Safety: TfL and LBSL are committed to Vision Zero and believe that no death or serious injury when travelling in London is either acceptable or inevitable. LBSL's aim is that by 2030 nobody will be killed in a collision involving a bus.
- Environmental Performance: LBSL support the target to reduce the Capital's CO₂ emissions by 60% by 2025 and become carbon neutral by 2050. To have a zero emission at tailpipe fleet by 2037. All new diesel powered buses will incorporate the latest technical designs, and systems to ensure the environmental performance of the vehicle delivers the highest possible sustainable clean energy standards and bus propulsion systems.
- Operational efficiency
- Accessibility: LBSL aim to continue to improve the accessibility of their bus services
- Passenger experience
- Aesthetics and image

This specification is structured to allow LBSL to ensure certain minimum standards are met in relation to its objectives and to easily assess to what extent individual models of bus might exceed those requirements and contribute more to their objectives.

1.3 Process

From time to time, LBSL may require additional control systems to be installed, and/or integrated into the base vehicle systems for the purposes of conducting demonstrations and/or trials to test and evaluate new or emerging technologies. The aim of these trials is to achieve the continuous improvement and enhancement of driver and passenger safety/comfort systems, and to ensure road space is shared as



safely as possible with other road users. These trials will also develop and promote innovations in London bus operations, bus design, accessibility features, and the continued reduction in harmful tailpipe emissions.

LBSL prior approval must be agreed for any exemptions/dispensations to allow for controlled deviation from the specified standards and/or performance requirements in this document. Request for exemptions/dispensation must be made in writing to the LBSL Nominated Officer. The reason(s), benefits, and any associated risks from such exemption/dispensation must be identified and assessed with the appropriate mitigations.

1.4 Terminology

London Bus Services Ltd (LBSL) is the subsidiary of Transport for London (TfL) that is responsible for the contracting and operation of London's bus network. LBSL and TfL are used interchangeably throughout the document.

The language used in this specification is typical of standards documents and shall be interpreted as follows:

- Mandatory requirements are indicated by phrases such as 'Must', 'Shall' or 'Required'.
- Where requirements are indicated by the word 'should' they are strongly recommended, and applicants shall present strong evidence to justify why their vehicle remains acceptable if these recommendations are not followed.
- Where requirements are indicated by the word 'may' they are optional and deviation is acceptable without presenting additional justification.

In addition to the above, some whole sets of requirements are indicated as being 'preferred'. These requirements are optional at the discretion of the OEM and operator but LBSL reserve the right to employ whatever commercial levers are at its disposal to encourage suppliers to choose to include these requirements and are more likely to select bids that include vehicles meeting the preferred requirements.

Section 4 of this document specifies TfL's safety requirements for all new vehicles. Included are details of requirements for new build vehicles entering the fleet in future years as per the Bus Safety Roadmap, highlighted with *italics*. The implementation timetable for future requirements can be found in Table 2-1.

The use of square brackets, [], indicates TfL's current assumptions and may be subject to change once further development work has taken place.

1.5 LBSL Approval

Approvals, changes and dispensations to this specification can only be given by LBSL's Nominated Officer in writing, or through a formal contract award letter issued by the Head of Bus Tendering and Evaluation (Richard Rampton).

The Nominated Officer is Tom Cunnington, Head of Buses Business Development. (Tom.Cunnington@tfl.gov.uk)



2 Status of Application of Requirements

Many aspects of this specification are mandatory. However, some items will not become mandatory until a future date. Before that time, some requirements may not be applicable at all, some must be followed if the system is fitted voluntarily, some permitted only as part of a controlled trial and some ‘preferred’ such that although not mandatory LBSL may employ commercial levers or incentives for buses that do comply with the requirements.

Table 2-1. Implementation timetable for actual and planned application of each set of requirements

Main section	Subsection	2018	End of 2019	2020	2021	2022	2024
Requirements	All	Required	Required	Required	Required	Required	Required
Safety	4.1 Fire	Required	Required	Required	Required	Required	Required
	4.2 Security	Required	Required	Required	Required	Required	Required
	4.3.1 Driver Assist: Acceleration	Required	Required	Required	Required	Required	Required
	4.3.2 Driver Assist: AEB	<i>Not Required</i>	<i>Trial Only</i>	Preferred	Preferred	Preferred	Required
	4.3.3 Driver Assist: ISA	Required	Required	Required	Required	Required	Required
	4.3.4.3 Direct & Indirect Vision: Direct vision score (DVS)	<i>Not Required</i>	Preferred	Preferred	Required	Required	Required
	4.3.4.3– Direct & Indirect Vision: Enhanced total Bus vision score (BVS)	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	Required
	4.3.4.4 Direct & Indirect Vision: Camera Monitor System (CMS): Mirror Replacement	<i>Not Required</i>	<i>Not Required</i>	Preferred	Required	Required	Required
4.3.4.1 Direct & Indirect Vision: Blind spot mirrors	<i>Not Required</i>	Required	Required	Not Required	Not Required	Not Required	



4.3.4.2 Direct & Indirect Vision: Camera Monitor system (CMS) Reversing	<i>Not Required</i>	Required	Required	Required	Required	Required
4.3.4.5 Direct & Indirect Vision: Front & Nearside Blind spot warnings	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	Required
4.3.5.3 Driver Assist: Pedal Application Error – Brake Toggling	<i>Not Required</i>	Preferred	Preferred	Required	Required	Required
4.3.5.5 Driver Assist: Pedal Application Error – Pedal standardisation	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Required	Required
4.3.5.2 Driver Assist: Pedal Application Error – Accelerator light system (ALS)	<i>Not Required</i>	Required	Required	Required	Required	Required
4.3.5.4 Driver Assist: Pedal Application Error – pedal acoustic feedback	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Required	Required
4.3.5.6 Driver Assist: Pedal Application Error – AEB logic	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	Required
4.3.6 Driver Assist: Runaway Bus Prevention	<i>Not Required</i>	Preferred	Preferred	Required	Required	Required
4.3.7 Driver Assist: Halt Brake	Required	Required	Required	Required	Required	Required
4.3.8 Driver Assist: Tyre Pressure Monitoring Systems	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Required



4.3.9 Driver Assist: Alcohol Interlock Installation Facilitation	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Required
4.4.1 Partner Assist: Acoustic Conspicuity - AVAS	<i>Not Required</i>	Required	Required	Required	Required	Required	Required
4.4.2 Partner Assist: Visual Conspicuity	Required	Required	Required	Required	Required	Required	Required
4.5.1 – 4.5.3 Occupant protection: Stairs, Seats, & Handrails	Required	Required	Required	Required	Required	Required	Required
4.5.4 Occupant protection: Guards	<i>Not Required</i>	Required	Required	Required	Required	Required	Required
4.5.5 Occupant Protection: Bus interior safety – Level 1 requirements	<i>Not Required</i>	Preferred	Preferred	Required	Required	Required	Required
4.5.5 Occupant Protection: Bus interior safety – Level 2 requirements	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	Preferred	Required
4.5.6 Occupant protection: Slip prevention	<i>Not Required</i>	Required	Required	Required	Required	Required	Required
4.6.1 Partner Protection: VRU frontal crashworthiness – Minimum geometry	<i>Not Required</i>	Preferred	Preferred	Preferred	Preferred	Preferred	Required
4.6.2 Partner Protection: VRU frontal crashworthiness – Enhanced geometry	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Preferred	Required



	4.6.3 Partner Protection: VRU frontal crashworthiness – Energy absorption	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Required
	4.6.4 Partner Protection: VRU frontal crashworthiness – Wiper protection	<i>Not Required</i>	Preferred	Preferred	Required	Required	Required
	4.6.5 Partner Protection: VRU frontal crashworthiness – Mirror Replacement Class II CMS	<i>Not Required</i>	<i>Not Required</i>	Preferred	Required	Required	Required
	Bus Safety Standard Overall Score	<i>Not Required</i>	Required	Required	Required	Required	Required
	4.5.7 Door Safety	Required	Required	Required	Required	Required	Required
	4.7 Miscellaneous Safety Features	Required	Required	Required	Required	Required	Required
Environment	All	Required	Required	Required	Required	Required	Required
Operational Efficiency	All	Required	Required	Required	Required	Required	Required
Accessibility	All	Required	Required	Required	Required	Required	Required
Occupant Experience	All	Required	Required	Required	Required	Required	Required
Aesthetics	All	Required	Required	Required	Required	Required	Required
Signs	All	Required	Required	Required	Required	Required	Required
Maintenance	All	Required	Required	Required	Required	Required	Required



3 Regulatory Compliance

3.1 Regulatory and TfL compliance

All vehicles must comply with all legislation applicable for buses driving in London. If there is any conflict between any requirement in this specification and any legislative requirement then the legislative requirement shall take precedence.

All London buses must be registered for road use in the UK. Registration requires that the vehicle must be approved via one of the following approval routes:

- EC Whole Vehicle Type Approval (ECWVTA)
- Small Series Approval (ECSSTA or NSSTA)
- Individual Vehicle Approval (IVA)

LBSL must be provided with a valid certificate of conformity for every vehicle supplied for use on the London bus fleet. LBSL must be notified of any changes to the vehicle design that would breach conformity of production of the vehicle type as approved by the relevant certification body (i.e. VCA if approved in the UK). Any vehicle found to not conform to the approved type shall be notified to LBSL and appropriate actions will be determined following an investigation.

Vehicles approved to ECWVTA do not need to be fully certified to any additional regulations.

Vehicles approved to National Small Series Type Approval or IVA shall in addition demonstrate that they, or the relevant components they are fitted with, also comply with the following regulations:

- UNECE Regulation 118-03 (Revision 02, Amendment 01) , as amended, on the burning behaviour of materials used in the construction of motor vehicles.
- UNECE Regulation 107, as amended, with respect to the fitment and technical standards of fire suppression systems in engine compartments of buses.
- All windows and glazing shall comply with UNECE Regulation 43
- All status and indicator lamps, even those for systems not required by type approval (e.g. pedal confusion indicator lights) comply with the relevant requirements of UNECE Regulation 121.
- The brake system, including all required interlocks and control systems that interact with the brakes, complies with the requirements of UNECE regulation 13
- Engine emissions shall comply with the latest legal Euro requirements for ECWVTA at time of bus certification.

All vehicles, regardless of approval type shall comply with the Public Service Vehicle Accessibility Regulations 2000 (PSVAR2000) as amended in respect of the fitment and technical standards for accessible equipment, systems and designs.



Compliance with any given regulation, or specific sections of such regulations, shall be demonstrated to LBSL either by providing copies of all relevant certificates of conformity or by providing a formal written declaration that the vehicle is in compliance with the Regulation or the required parts of the Regulation.

Buses shall not be modified between registration and entry into service. If any modifications are made that affect the ability of the vehicle to carry the plated load, or the brake or steering systems or their mode of operation, then the OEM shall submit a Notifiable Alteration to DVSA and obtain approval for the modification.

All buses must comply with all relevant current legislation and take account of any intended legislative discussions that are considered imminent within the first 6 months of the bus's operational life. For clarity, this means within 6 months of the first delivery made as part of each specific order for new buses. It does not relate to when that model of bus first entered service.

LBSL reserves the right to audit any buses entering or already entered into service, costs associated by this, as well as exploratory testing or trials will be borne by TfL.

All costs associated with development and certification of vehicles by OEMs shall be borne by them unless expressly agreed with TfL.

3.2 Test Process

3.2.1 Testing and Certification Requirements

OEMs and/or bus operators are permitted to be present during preparation and testing but are not permitted to interfere with or adjust the bus without full agreement of the testing service and the relevant approval authority within TfL.

Reference information about the bus will be noted by the test service and recorded on the test certificate issued. Any adjustments will be noted by the testing service.

Laptops must not be connected during certification tests, either via hardware/cabling, or via wireless/telematic connection.

ECU flash file and other control software must be as used in London operation.

Certification tests must be in the same condition and consecutive, when multiple tests are required.

Throughout this specification and the associated Attachments document, where Test Service is used, this refers to an independent Test House, which has and can provide evidence of being UKAS (or equivalent) accredited to carry out ECWVTA.

Table 3_1 Testing and certification requirements for relevant requirements.

Requirement	Test / Assessment requirement	Evidence requirement
Attachment 1	Independent Test Service	Independent Test Report
Attachment 2	Independent Test Service	Independent Test Report
Attachment 5	Independent Test Service	Independent Test Report
Attachment 6	Self Assessment	Auditable Evidence Pack
Attachment 7	Independent Test Service or	Independent Test Report or



	Self Assessment	Auditable Evidence Pack
Attachment 8	Independent Test Service or Self Assessment	Independent Test Report or Auditable Evidence Pack
Attachment 9	Independent Test Service	Independent Test Report
Attachment 15	Independent Test Service	Independent Test Report
Attachment 16	Self Assessment	Auditable Evidence Pack
Attachment 17	Independent Test Service	Independent Test Report
Attachment 19	Independent Test Service or Self Assessment	Independent Test Report or Auditable Evidence Pack
Attachment 24	Independent Test Service	Independent Test Report
Attachment 26	Independent Test Service	Independent Test Report
Attachment 28	Independent Test Service	Independent Test Report
Attachment 30	Independent Test Service	Independent Test Report
Attachment 32	Independent Test Service	Independent Test Report or Auditable Evidence Pack
Attachment 34	Self Assessment	Auditable Evidence Pack
Attachment 36	Independent Test Service	Independent Test Report
Attachment 38	Self Assessment	Auditable Evidence Pack
Attachment 39	Self Assessment	Auditable Evidence Pack
Attachment 41	Independent Test Service	Independent Test Report
Attachment 42	Self Assessment	Auditable Evidence Pack

3.2.2 Compliance Carryover Between Vehicle Types and Variants

Where carryover of compliance between vehicle Types or Variants is intended, evidence of critical Component and/or installation commonality is required to be submitted to TfL for review.

Any Vehicle Requirements not captured in Table 3_2 below do not allow for any possibility of compliance carryover.

For the purposes of this section, the following definitions are applied:

- **Type** - refers to a Single or Double Deck vehicle (e.g., Single and Double Deck vehicles are different Types).
- **Variant**- refers to a Single or Double Deck vehicle with a specific layout or length (e.g., 10.3 m and 10.5 m Single Deck vehicles are the same Type, but different Variants).
- **Whole Vehicle** - Testing is undertaken on the Component or system as it is installed in the vehicle. The 'Whole' vehicle must be presented for testing.
- **Auditable Self-Assessment** - a graphical or tabular assessment of interior components or parts, presented as a comprehensive Data Pack.



- **Component (Certification Type)** - Testing may be undertaken on the component only, it is not necessary for the component to be installed in the vehicle if so desired.
- **Component (compliance)** - refers to a specific component or safety feature (e.g., the wheelchair floor logo, AEB system, ISA system, Occupant Friendly Interior Assessment are all defined as Components).
- **Common/Commonality** - the level of similarity between one component, part or layout from one vehicle Type or Variant and another.
- **Full/Fully Common** - where a component, part, layout is identical from one vehicle Type or Variant to the next.
- **Sufficient Commonality** - for some components, where minor differences in shape, layout, position or size exist between one vehicle Type or Variant and another, TfL may accept this as 'Common'.

Where carryover of compliance between vehicle Types or Variants is intended, evidence of critical Component and/or installation commonality is required to be submitted to TfL for review.

Table 3_2 Compliance Carryover Requirements between Vehicle Types and Variants

Attachment	Certification Type & Level	Compliance Conditions & Exceptions
1 - Emissions	Whole Vehicle (Type)	No carryover of compliance between Types allowed. For Variant compliance a \pm [250] kg Test Mass is allowed, provided all critical propulsion and HVAC components remain fully common
2 - Noise test	Whole Vehicle (Type or Component)	No carryover of compliance between Types allowed. For Variant compliance carryover is allowed, provided all critical AVAS Components remain sufficiently common and the Worst-case Variant (longest version) is tested.
5 - Driver - Passenger Intercom	Whole Vehicle (Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per Component provided installation requirements and positions remain sufficiently common
6 - Fire Retardant Properties	Auditable Self-Assessment (Component)	Component compliance may be used to cover multiple vehicle Variants and Types where full commonality to a baseline vehicle is shown, deviations from this baseline must reference the baseline assessment and be covered by an appropriate addendum
8 - Hand Rail Layout	Whole Vehicle (Variant)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types



9 - HVAC	Whole Vehicle (Type or Component)	No carryover of compliance between Types allowed. For Variant compliance carryover is allowed, provided all critical AVAS Components remain sufficiently common and the Worst-case Variant (longest version) is tested.
10 - Destination Display	Component	Compliance evidence required per Component only, carryover between Types and Variants allowed per Component provided installation requirements and positions remain sufficiently common
11 - CCTV	Whole Vehicle (Type)	No carryover of compliance between Types allowed. Carryover between Variants allowed per Component provided installation requirements and positions remain sufficiently common
15 - AEB	Whole Vehicle (Type or Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain sufficiently common, and compliance is achieved for the Worst-case Type or Variant
17 - ISA	Whole Vehicle (Type or Component)	No carryover of compliance between Types allowed. Carryover between Variants allowed per Component provided critical Component (ISA unit aerial) installation requirements and positions remain sufficiently common
19 - Bus Vision Score - Direct Vision	Whole Vehicle (Type or Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
19 - Bus Vision Score - Bus Vision	Whole Vehicle (Type or Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
22 - CMS	Whole Vehicle (Type or Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
24 Blind Spot Warning	Whole Vehicle (Type or Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain sufficiently common, and compliance is achieved for the Worst-case Type or Variant
26 - Pedal Application Error - ALS	Whole Vehicle (Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain sufficiently common
26 - Pedal Application Error - BTS	Whole Vehicle (Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain sufficiently common



28 - Runaway Bus Prevention	Whole Vehicle (Component)	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain sufficiently common
30 - AVAS	Whole Vehicle (Type or Component)	No carryover of compliance between Types allowed. [For Variant compliance carryover is allowed, provided all critical AVAS Components remain sufficiently common and the <u>Worst-case</u> Variant (longest version) is tested.]
32 - Anti-Slip Flooring	Component	Compliance evidence required per Component only, carryover between Types and Variants allowed per component provided installation requirements and positions remain common
34 - Occupant Friendly Interiors	Auditable Self-Assessment (Component)	Component compliance may be used to cover multiple vehicle Variants and Types where full commonality to a baseline vehicle is shown, deviations from this baseline must reference the baseline assessment and be covered by an appropriate addendum
36 - Frontal Crashworthiness - Bus Impact Test	Whole Vehicle (Type or Component)	If sufficient commonality of design and construction is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
38 - Frontal Crashworthiness - Minimum Geometry	Auditable Self-Assessment (Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
39 - Frontal Crashworthiness - Enhanced Geometry	Auditable Self-Assessment (Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
41 - Frontal Crashworthiness - Protection	Auditable Self-Assessment (Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types
42 - Complex Electronic Components	Auditable Self-Assessment (Component)	If sufficient commonality of design and placement is evidenced, Component compliance may be used to cover multiple vehicle Variants and Types

3.3 Vehicles types and variants

The variants shall be defined as per Regulation (EU) 2018_858.

3.3.1 Type-, variant- and version designations

In addition to defining the type vehicle and variant as required by VCA, and generating the associated alpha-numeric TVV code, TfL require an equivalent code for defining different design variations within each variant This Safety Standard designation shall be assigned to denote the relevant safety features assessed. The purpose is to provide TfL with a clear indication of exactly which safety features are on the bus, and have been assessed against the Bus Safety Standard. The



performance of each bus shall be assessed at each different TVV-SS level, because any additional feature of the SS added will result in a different safety performance.

For a hypothetical example, it might be possible to specify a bus with TVV code Type A, Variant C and Version F with more than one seating and hand rail layout that would score differently in section 4.5 Occupant Protection. Then each different possible layout shall be provided a unique code such that the correct specification can be identified in subsequent operator tenders.

This Safety Standard designation is referred according to the following table:

[Note that this table is subject to change; it needs to be fully defined and agreed between the relevant approval authority within TfL and the Test service.]

Table 2_2 Safety Standard designation table

Description		Code	
Advanced Emergency Braking - any system that is active at speeds of 10 km/h or more and uses information from sensors to detect an imminent collision and, if the driver fails to take appropriate avoidance action, automatically applies sufficient braking to avoid the collision or at least reduce the collision speed		AEB	
Intelligent Speed Assistance – system fitted to a vehicle to restrict its speed to the prevailing speed limit.		ISA	
Direct & Indirect Vision- the proportion of each assessment zone visible to the driver through the direct & indirect field of view.	Vision from vehicles	DIV-VIS	
	Blind spot mirrors	DIV-BSM	
	Camera Monitor Systems	Reversing	DIV-CMS-REV
		Mirror replacement	DIV-CMS-MIR
	Enhanced indirect and direct vision	DIV-INDDIR	
	Front & nearside blind spot warnings	DIV-BSW	
Pedal Application Error – an incident where a driver mistakenly presses the accelerator pedal instead of the brake pedal.	Foot placement	Footwell camera	PAE-FPL-CAM
		Pedal standardisation	PAE-FPL-STD
		Brake toggling	PAE-FPL-TOG
	Driver recovery	Pedal Indicator Light	PAE-REC-PIL
		Pedal acoustic feedback	PAE-REC-PAF
	Vehicle intervention	AEB logic	PAE-INT-AEB



Description		Code	
Runaway Bus Prevention – a bus without the park brake engaged that moves in any direction in an uncontrolled manner without any input from a driver		RUN	
Halt Brake – an automated braking system that prevents a bus from moving under certain conditions.		HBR	
Tyre Pressure Monitoring System – a system fitted to a bus to warn the driver when a loss of pressure occurs in a tyre		TPMS	
Alcohol Interlock Installation Facilitation - is a standardised interface that facilitates the fitting of aftermarket alcohol interlock devices in motor vehicles		AIIF	
Acoustic Conspicuity - systems is to make a quiet running vehicle (e.g. hybrid or electric) as conspicuous to a pedestrian as a typical diesel engine.		ACO	
Visual Conspicuity - systems is to make a vehicle more visually conspicuous to a pedestrian.		VCO	
Occupant Protection – identification of injury hazards present in the vehicle with the objective of encouraging safer vehicle designs	Staircase	OCC-STR	
	Seats	OCC-SEA	
	Handrails	OCC-HDR	
	Guards for exposed seats	OCC-GRD	
	Bus Interior Safety Assessment	OCC-BISA	
	Flooring and slip prevention	OCC-FLR	
	Door safety	OCC-DOOR	
Partner Protection - the impact protection provided by the front end of a bus in the event of a collision with a pedestrian	VRU Frontal Crashworthiness	Minimum geometry	VCW-GEOMIN
		Enhanced geometry	VCW-GEOENH
		Energy absorption	VCW-NRG
		Wiper protection	VCW-WIP
	Class II CMS	DIV-CMS-MIR	
Miscellaneous		MISC	



4 Safety

4.1 Fire Safety

All materials used in the construction of the passenger saloon and structure separating the saloon from the engine compartment must meet the fire-retardant standards defined in Attachment 6.

Engine and combustion heater compartments shall be equipped with a fully automatic fire suppression system compliant with UNECE Regulation 107 (As Amended). It shall be capable of rapid deployment to extinguish a fire before passenger safety is compromised or serious bus damage is sustained. All vehicles shall have a Regulation 107 compliant system, regardless of powertrain, including zero emission vehicles.

On bus start up, the fire suppression system shall provide the driver with audible notification that it is operative and free from defect.

OEMs shall complete a full fire risk assessment for each type of bus covering as a minimum the engine bay and combustion heater compartment. This should be undertaken in conjunction with the Fire Suppression System (FSS) manufacturer, where this is not the bus OEM, and Bus operators who have the necessary expertise. The outputs from the risk assessment should identify all potential sources of fire and identify the type and location of fire detection devices and fire suppressant dispensing outlets. It should also define the FSS maintenance requirements.

All identified potential sources of fire in the engine bay shall be protected by an effective FSS. This includes any at risk areas behind the engine such as starter motors or filter assemblies. This may increase the length of the trace tube or require additional nozzles. It may also require larger capacity fire suppression cylinders.

The system shall provide accurate and early detection of fires, and multi point dispensing of fire suppressant material targeted at high-risk sections of the engine bay. Manual activation or override by the driver shall not be permitted.

On detection of a fire, the systems shall:

- Provide the driver with immediate audible notification of fire detection;
- Shut off fuel supply to the engine bay and effectively isolate the fuel tank; and
- Remove power to the cooling fan

4.1.1 Smoke Detectors

All bus types shall be equipped with concealed smoke detectors, located as per Figure 4_1 below.

- Double-deck buses shall be equipped with 3 concealed smoke detectors.
 - 2 detectors on the upper deck
 - 1 located at the front
 - 1 located at the rear
 - 1 detector shall be located on the lower deck at the rear of the seated area

- Single deck buses shall be equipped with 1 concealed smoke detector at the rear of the seated area

All smoke detectors on all bus types shall be located in the approximate area shown in Figure 4_1. No smoke detector is to be positioned less than 100 mm from any vertical surface.

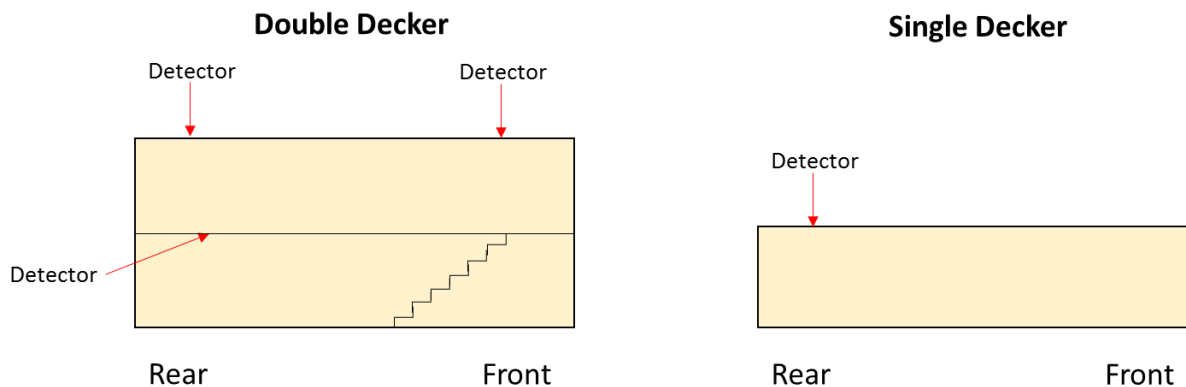


Figure 4_1 Smoke detector location requirements for Single and Double Deck vehicles

An audible and visual warning shall clearly inform the driver of the activation of any detector.

The legally required manual engine emergency shut down device must be accessible without the need to open the main engine bay cover. It must also be of a type that allows the engine to be restarted from the driver's cab, provided the main rear engine bay cover is closed. The main engine bay cover must be kept locked when the bus is in service.

For vehicle types that have a high voltage system, shutdown shall mean shutting down and isolation of the high voltage system.

NOTE: For the purpose of this requirement engine and engine bay mean the vehicle powertrain system and locale, and shall apply to all powertrain types.

The OEM shall demonstrate compliance with these requirements by providing copies of the risk assessments to LBSL.

4.2 Security

4.2.1 Protecting the driver

All buses shall be fitted with a partition screen separating passengers and the driver.

The driver partition screen shall not include speech holes. The design must allow adequate two-way driver/passenger communication that is accessible to all customer groups. This can be achieved with or without additional communication devices, such as passive or electronic two-way communication systems, and shall be certified in accordance with Attachment 5: Driver-Passenger Two way Communication Protocol.



The driver's partition screen, including its mountings, the structures supporting it and the hinges and catches forming part of any section designed to open to allow driver access and egress, shall be designed to:

- Protect the driver from sustained physical attack from any person.
- Reduce substantially the driver's exposure to pathogen contaminated respiratory droplets and aerosols.
- Minimise the likelihood of a pressurised spray and/or fluids directed at the screen from passing through at any point.
- Be tamper proof with all critical components designed to be difficult to forcibly remove.

The screen, and any communication system hardware mounted in it, shall:

- Be free from rattles during normal driving.
- Not have any uncovered openings or holes.
- Not have doors, hatches, flaps or covers that can be opened or removed without the use of tools or keys.
- Be fitted with a flexible seal, draught seal or other flexible arrangement to close gaps where they exist, including those around its outer edges, around the driver's door and near equipment.
- Be easy to clean and provide adequate access to do so.

For vision assessment:

- The screen shall not restrict or distort driver view to passenger entrance, interior and exterior mirrors or forward exterior view.
- The screen shall be made of transparent materials with a transmittance value of >70 %.
- For clarity, the screen shall be included in the Bus Vision Standard Test and Assessment Protocol, Attachment 19.
- The screen shall be free of substantial reflections and will be assessed for glazing angle as per Attachment 19.
- Fixing, joining and sealing materials shall either be similarly transparent to the screen or their area minimised.

Screen materials shall:

- Be impermeable to air.
- Be durable and long lasting.
- Be resistant to discolouration, scoring or cleaning chemical damage.
- Not require regular replacement as part of a maintenance process of equipment, including the Electronic Ticket Machine (ETM) and validator.
- Be rigid material with the relevant markings showing type-approval conformity.
- Resistant to mould growth.



The driver must be further protected by an independent “siren/common network fleet sound” assault alarm also activating the bus hazard lights.

The driver’s cab signalling window shall be resistant to assault or protected by a device resistant to assault.

4.2.2 Discouraging pickpockets

Passenger seats shall be suitably designed to restrict the potential of pickpockets to operate whilst utilising the seating immediately rearward.

4.3 Driver Assist

4.3.1 Acceleration performance

The combined engine and transmission acceleration controls shall limit the bus to a rate that provides the driver with adequate driving acceleration in the fully laden condition, whilst not subjecting the passengers to excessive forces that potentially cause the passengers to become unstable. The maximum rate of acceleration shall be less than 1.2m/s^2 under all load conditions.

4.3.2 Advanced Emergency Braking (AEB)

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

It should be noted that AEB is intended to operate only in the last second or two before an imminent collision. The driver remains responsible for all aspects of driving, including collision avoidance, at all times.

4.3.2.1 Requirements

Buses shall be fitted with AEB systems complying with the following requirements:

- It shall be tested in accordance with LBSL’s Advanced Emergency Braking Assessment Protocol (Attachment 15) and it must attain a performance score greater than [30] %.
- As from 2027, the minimum score shall be increased to a level to be confirmed after consideration of data from monitoring of in-service performance, in particular, the frequency and consequences of false positives.
- Buses equipped with AEB shall experience false positive brake applications less frequently than once every [300,000] km on average.
- The system shall provide the driver with a status indicator that will inform the driver if the system is unavailable for any reason, or if performance is degraded because of imperfect conditions such as sensor misalignment. Where this occurs, the system shall fail to a standard equivalent to an identical vehicle not fitted with AEB. The warning light illuminated in such cases shall be amber.
- The bus OEM must make signals regarding AEB function available for recording by the CCTV system (specified separately) and/or any other appropriate data recording device specified by the vehicle operators. These signals shall at all times indicate the status of the AEB system as follows:



- Enabled, manually deactivated (if any deactivated mode, for example for service, is provided) or unavailable (for example due to self-diagnosed defect or adverse weather)
 - Warning active
 - Brake demand active
 - Level of braking demanded

4.3.2.2 Demonstrating compliance with requirements

Where a manufacturer submits a vehicle for approval under this standard, then they shall supply a full matrix of test results that they expect to achieve in the sign-off test in accordance with attachment 15. This allows the sign-off test to be a validation of the manufacturer's self-certified score such that, assuming the expectations are met, a reduced number of tests is required. The manufacturer shall also ensure that the test activity is supported with any necessary engineering expertise and diagnostic equipment to quickly resolve any technical difficulties with the AEB system, for example, re-setting fail safe mechanisms triggered by multiple AEB activations in a short time.

Manufacturers shall demonstrate compliance with the requirements with an independent test report covering the attachment 15 requirements and by a documentary package produced in compliance with attachment 42 on complex electronic control systems, covering all aspects of the system design, performance and safety concept. In addition to the general requirements of attachment 42, the package should contain evidence to demonstrate that:

- The AEB approved is identified by a robust and transparent system managing the specification of hardware and version of software or firmware involved.
- Where AEB approval is intended to cover a range of bus types, variants or versions, the manufacturer shall consult TfL prior to the commencement of testing or certification to agree the approach. Evidence shall be presented in relation to the type, variant or version that represents the likely worst case performance within the range considering both true and false positive performance. This assessment must consider, as a minimum:
 - The location of the sensors in X, Y and Z axes
 - Any change in specification affecting the response time of the brake system (the time taken between issuing a braking demand and achieving 90 % of the target level of deceleration).
 - Any change in the maximum level of mean fully developed deceleration¹ that can be achieved.
 - Any change in wheelbase, front overhang, or steering geometry
 - Any difference in the performance of sensors intended for the measurement of current, or prediction of future, motion (e.g. steering wheel angle sensors, acceleration or angular rate sensors).

¹ As defined by UNECE Regulation13 as amended.



- The design and verification processes employed provide strong evidence that the false positive requirements will be achieved in service.

Where substantial vehicle mileage may be required to prove compliance with the requirement on false positive rate, it is acceptable to use evidence gained during development of the bus and tuning of the AEB algorithm, provided the process can still prove the final algorithm would have produced the required result if it had been in place throughout. It is not essential to undertake a separate certification road trial. One example of an acceptable process is described generically below:

- Physically drive the vehicle in mixed city environment while recording the sensor inputs and AEB decision making and output requests until a false positive occurs at 'X' km.
- Re-tune the algorithm to eliminate the false positive and update the software version
- Re-run the first 'X' km in simulation with the new software version and confirm it now completes the same distance over the same route without any false positive
- Repeat the steps above as needed until the distance accumulated in the trial reaches [750,000] km ([2.5] times the prescribed minimum distance between false positive events).

Manufacturers are free to use a different process but shall show in the documentation package produced in accordance with attachment 41, that the process is at least as robust a verification as that outlined and that any simulation used in the assessment has been proven to correlate well with real world testing.

Manufacturers may, subject to confirmation by TfL, use mileage accumulated in major cities other than London as part of the verification process, provided it can be demonstrated that the cities are comparable in terms of population density, traffic density, road layouts and general environmental complexity.

4.3.2.3 Defining a False Positive

Time to collision (TTC) is considered critical in the assessment of AEB. TTC is defined as the time within which a collision with another person, vehicle or object will occur if all parties involved maintain the same speed and trajectory.

Where no other person, vehicle or object is on a collision course with the bus, then the time to collision is considered to be infinite.

For the purposes of verification of compliance, a false positive AEB intervention shall be defined as follows:

- The AEB brake command results in a peak deceleration of 1.50 m/s² or more: **AND**
 - Analysis of the traffic situation shows that the time to collision at the moment the AEB commanded braking exceeded the greater of [1.4] seconds or the calculated TTC at the last point of braking; **OR**



- Analysis of the traffic situation showed that an alert human driver did not apply the footbrake within [1.2] seconds of the AEB braking command;
- Time to Collision at the Last point of braking is calculated by:

$$TTC = \frac{U}{2a}$$

- Where U is the vehicle speed in the instant immediately before intervention in metres/second and a is the mean braking deceleration that represents the minimum that would be expected to deviate from normal driving, assumed here to be 3 m/s².

TfL acknowledge that it may not be possible for a single definition to reliably categorise every situation that may occur in the real world into a binary assessment of either true or false positive. If manufacturers consider that this definition of false positive unfairly captures events they consider to be true positives in sufficient numbers to significantly affect their ability to pass the requirement, then they may apply for derogation on the basis of a robust evidence case showing why the categorisation of events is incorrect.

4.3.2.4 Monitoring Compliance In-Service

In addition to proving compliance before entry into service, as defined above, TfL will also monitor compliance in-service. As such, bus operators shall:

- Record an event every time the FCW or AEB is activated. For each AEB event, the braking demand, initial bus speed, peak deceleration, mean deceleration, and final speed when AEB becomes inactive shall recorded, alongside the total time duration of the event and true false markers to identify:
 - Was the brake pedal pressed at the moment of AEB activation
 - If not, was the brake pedal subsequently depressed within 1.2 seconds of AEB activation
 - Was the accelerator pedal depressed at the moment of AEB activation
 - Was the accelerator pedal depressed after AEB activation but within 1.2 seconds of AEB activation.
- Provide data to TfL, no less frequently than once per 4 week reporting period, defining the absolute number of AEB interventions and the rate per km of the interventions for all buses of the type, variant or version covered by this approval, divided into categories of peak deceleration in accordance with Table 4_1 below.

Table 4_1 AEB Braking Intervention Summary Table

Intervention type	Number of interventions	Rate of interventions (number per bus km)
Forward collision warning only		



Braking intervention 0 m/s ² to 1 m/s ²		
Braking intervention 1 m/s ² to 2 m/s ²		
Braking intervention 2 m/s ² to 3 m/s ²		
Braking intervention 3 m/s ² to 4 m/s ²		
Braking intervention 4 m/s ² to 5 m/s ²		
Braking intervention 5 m/s ² to 6 m/s ²		
Braking intervention 6 m/s ² to 7 m/s ²		
Braking intervention 7 m/s ² to 8 m/s ²		
Braking intervention 8 m/s ² to 9 m/s ²		
Braking intervention > 9 m/s ²		

- Permanently record [5] minutes of CCTV footage either side of the time of each AEB event, retain such footage for at least [3] years and make it available to TfL for analysis, subject to agreeing legally compliant data share agreements, which shall not be unreasonably withheld.

[TfL reserves the right to withdraw approval for a particular vehicle and/or AEB if in-service monitoring identifies that a system is not compliant with the requirements of this specification by virtue of its design and construction. Allowance will be made for the influence of any issues with in-service maintenance or inappropriate use or abuse that was not reasonably foreseeable by the manufacturer.]

4.3.3 Intelligent Speed Assistance (ISA)

An Intelligent Speed Assistance (ISA) system is an aid to the driver to keep within the speed limit and does not absolve the driver of responsibility for complying with speed limits or selecting the most appropriate speed for the prevailing road conditions, which may be lower than the posted speed limit.

TfL will regularly provide updates of speed limits of all roads through the TfL Digital Speed Map (see map management section of this document). The TfL Digital Speed Map incorporates all public highways in every London borough.

The ISA Software version and map version should be accessible either:

- via the vehicle dashboard
- OR
- via use of a Laptop that is connected to the vehicle CAN Bus

All OEMs shall register the fleet number, vehicle registration number and ISA unit serial number with the ISA unit manufacturer prior to installation.

Where new buses are equipped with an Intelligent Speed Assistance system, it shall:

- Operate at all times when travelling on any public highway defined by the TfL Digital Speed Map of London.



- Limit the vehicle speed to the prevailing speed limits as indicated by the TfL Digital Speed Map. When the vehicle is prevented from exceeding the relevant speed limit, this shall be termed the Restricted Operating Mode (ROM).
- Be tested in accordance with the procedures defined in LBSL's Intelligent Speed Assistance Assessment Protocol (Attachment 17) and achieve a 'Pass'.
- Have no adverse effects on the fuel consumption or emissions.

4.3.3.1 Bus Integration

The system must be fully integrated by the bus OEM. Post vehicle homologation fitment of aftermarket equipment is not permitted.

For buses equipped with iBus 1, ISA can utilise the existing iBus GPS antenna (which provides reception on the L1 band) or any other existing bus architecture. The existing iBus antenna can be utilised through using a Radio Frequency (RF) splitter. The RF splitter is required to be approved for use by LBSL. LBSL accept the locational variance in geographic accuracy this entails will be within a 20-metre tolerance.

For buses equipped with iBus 2, the iBus 2 GPS antenna must also be used to provide the GPS signal for ISA by using an RF splitter. The RF splitter must be approved for use by LBSL.

The system shall obtain the speed of the vehicle from the appropriate Fleet Management System (FMS) data field via the FMS Gateway or directly from the CAN. This shall be the same signal which is reflected on the speedometer visible to the driver.

The FMS & CAN vehicle speed must be sufficiently accurate to comply with the requirements of UNECE Regulation 39 on speedometers.

4.3.3.2 Operational

When entering a speed limited zone or transitioning to a zone with a lower limit, the vehicle must comply with the following performance specification;

- There shall be no intervention by braking to enforce a speed reduction. Energy recovery and/or engine retardation up to the level where the brake lights would be applied is permitted.
- The system will impose a speed limit as soon as all conditions of ROM are met.
- The driver should be notified of any enforced retardation of the vehicle.

When travelling in a speed limited zone and the vehicle is below the prevailing limit there shall be no change in the vehicle performance characteristics. The vehicle shall remain in a smooth driving style for the sake of passenger comfort.



With a vehicle in ROM the ISA system should guard/mitigate against the vehicle accelerating unexpectedly, if the accelerator pedal is depressed during the transition, when the vehicle either:

- exits a speed limited zone,
- enters a zone with a higher limit,
- or deactivates itself for any reason, for example as a consequence of loss of GPS position or speed signal (however sourced),

then when the vehicle exits a speed limited zone the vehicle shall be returned to normal operating mode.

It shall be possible to disable the speed limiting system when the ignition is on and the vehicle is stationary. This shall be possible for qualified personnel only and not for the driver. As a minimum, the action of disabling the system shall be possible by connecting a suitably equipped laptop to the vehicle. OEMs may also provide an additional means of disabling the system using the fleet management telematics.

4.3.3.3 GPS Accuracy and Driver Warnings

The driver shall be informed of ISA fitment. This may be via a sticker, light, voice instruction, or other indicator.

In the event of loss of GPS, FMS or CAN speed signal the system will fail safe whereby no digital speed map limit is implemented.

The system shall guard/mitigate against spurious signals/GPS inaccuracy for instances when a vehicle is travelling along parallel roads with varying limits or travelling through complex road junctions.

Upon traveling within a speed limited zone for a distance of 30.0 m and a time of 5.0 seconds the vehicle shall be identified as being within a speed limit zone and be required to activate a ROM. A time of 3 seconds must not be exceeded before the ROM has been implemented. Therefore, assuming the vehicle speed is greater than 10mph the maximum time before implementing the ROM shall be 8 seconds.

Under the following conditions the ISA system shall display a green continuous dash lamp:

- System installed, functioning correctly and inside speed limited zone.
- Transitioning between speed limited zones
- Enforcing a speed limit (Restricted Operation Mode).

Under the following conditions the ISA system shall inform the driver via a white light:

- Vehicle in fail safe mode (GPS signal loss)
- Vehicle not within a speed limited zone
- System disabled

Under the following conditions the ISA system must display a continuous amber dash lamp:



- System fault present affecting the operation of ISA
- Vehicle in fail safe mode (CAN and/or FMS communication loss)
- Any other condition resulting in the condition of ROM not being implemented

The ISA symbols shall be:



The speed limit of the current road shall be displayed with a speed limit symbol, for example:



The speed limit indicator is mandatory on all vehicles.

It shall flash to indicate an excess of the speed limit. The 'Image Flashing' section of ISO 15008 shall be adhered to, and a flashing frequency of 1Hz to 5 Hz used.

No audible indicator shall be permitted.

4.3.3.4 Map Management

TfL shall provide a Digital Speed Map which identifies all speed limited zones to be applied by the ISA system.

The file will be made available in one of the follow formats on request to TfL.

- Shapefile (ESRI)
- MITAB (MapInfo)
- KMZ (Google KML)
- GeoJSON (Geographical Java Script Object Notation)
- Geodatabase (gdb)
- GPKG (Open GeoPackage)

The Bus Operator shall ensure that any updates to the map are uploaded to the vehicle within 5 weeks of being released.



It is envisaged that TfL will carry out an annual map update to capture changing speed limits. Note: any reduction in carriageway speed limit prior to ISA map update being available, does not absolve the drivers of responsibility for adherence to speed limits or appropriate speed.

Whilst this is envisaged to be the norm, TfL would require operators to maintain the capacity to update maps immediately on an 'extraordinary measures/emergency' basis.

The digital speed map updates must be uploaded using either portable data storage, existing local wi-fi network systems, or via cellular network connection. To be agreed by the OEM and bus operator.

An additional antenna for updating the digital map is prohibited.

Access to the mechanism or ECU for updating the map should be physically protected and not easily accessible to the driver or unqualified personnel. For example, in an office with access control for remote system updates, or behind a locked panel for local updates on a bus.

4.3.3.5 System Failure

In the event of a system failure the system shall notify the driver via displaying an amber light, that the system has a fault. The fault shall be logged in the bus memory until inactive and memory is cleared.

ISA is a driver aid to improve driver performance. Drivers remain capable of driving the vehicle at safe speeds even when the system is unavailable. Thus, system failures or other that lead to an activation of the amber light does not mean the vehicle is unroadworthy (subject to any change in regulation).

4.3.4 Direct and Indirect Vision

All buses shall allow the driver to have sufficient vision of their surroundings to allow the execution of all driving tasks required in service in London.

All buses shall have a high standard of direct and indirect vision in areas close to the vehicle where vulnerable road users are at particular risk of collision with a bus performing low speed manoeuvres.

4.3.4.1 Blind Spot Mirrors

All buses shall, in addition to the mandatory fields of vision described in UNECE Regulation 46, be able to see two rectangular areas on the ground plane with boundaries defined as described below.

- Nearside (Left Side) Blind Spot Zone:
 - a) Forward boundary: parallel to the frontal plane of the bus and 0.5m rearward of the driver's ocular reference point
 - b) Rearward boundary: parallel to the frontal plane of the bus and 4m rearward of the driver's ocular reference point



- c) Inner boundary: parallel to the longitudinal plane of the bus and passing through the outermost point of the nearside (left side) structure of the bus within the forward/rearward boundaries
- d) Outer boundary: parallel to the longitudinal plane of the bus and 2m outboard from the inner boundary defined in (c) above.
- Offside (Driver Side) Blind Spot Zone:
 - a) Forward boundary: parallel to the frontal plane of the bus and 0.5m rearward of the driver's ocular reference point
 - b) Rearward boundary: parallel to the frontal plane of the bus and 4m rearward of the driver's ocular reference point
 - c) Inner boundary: parallel to the longitudinal plane of the bus and passing through the outermost point of the offside (driver side) structure of the bus within the forward/rearward boundaries
 - d) Outer boundary: parallel to the longitudinal plane of the bus and 2m outboard from the inner boundary defined in (c) above.

These ground plane areas should be measured in accordance with the methods prescribed in UNECE Regulation 46.

The reflecting surface and coefficient of reflection of the mirror achieving visibility of the above zone shall comply with the requirements for a class V mirror in UNECE Regulation 46.

The bus OEM or, where installed as a component on an existing vehicle, the mirror supplier, shall provide documentary evidence of compliance with these requirements.

4.3.4.2 Camera Monitor System (CMS): Reversing

All buses shall be equipped with a rear-view Camera Monitor Systems (CMS) compliant with UNECE Regulation 158 as amended, for system performance, technical quality and field of view requirements. In order to ensure optimum interaction with the driver, the CMS shall in addition meet the following criteria:

- Rear-view CMS monitor images shall only be visible to the driver when the reverse gear is engaged

The bus OEM or, where installed as a component on an existing vehicle, the CMS supplier, shall provide documentary evidence of compliance with these requirements. Supplier certification or manufacturer self-certification will be accepted.

4.3.4.3 Direct Vision Score (DVS) and Enhanced total Bus Vision Score (BVS)

The Direct Vision Score (DVS) requirement only applies to new vehicle entering the fleet from 2021 as per the Bus Safety Roadmap for new buses.

The Bus Vision Score (BVS) requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses.



All buses shall be assessed in accordance with LBSL's Bus Vision Standard Assessment Protocol (Attachment 19), reporting the direct vision performance score (DVS) and overall bus vision standard performance score (BVS) for each bus model or bus model variant (as appropriate).

Direct Vision Score: All buses must meet the minimum direct vision performance score (DVS) requirement of 75 %.

Bus Vision Score: All buses must meet the minimum overall bus vision standard performance score (BVS) requirement of 75 %.

The bus OEM shall provide documentary evidence of compliance with these requirements.

4.3.4.4 Camera Monitor System (CMS): Mirror Replacement

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

All buses shall use Camera-Monitor Systems (CMS) that are compliant with UNECE Regulation 46 to replace physical mirrors on the bus, at least for the Class II and IV fields of vision (FOV) defined by the same Regulation and the blind spot FOV defined by the bus vehicle specifications for blind spot mirrors (section 4.3.4.1).

These requirements shall be evaluated based on the driver's FOV from the ocular reference point as defined by UNECE Regulation 46 (635 mm vertically above the seating reference point specified in Annex 1 of ECE/TRANS/WP.29/78/Rev.6).

In order to ensure the optimum interaction with the driver, the CMS shall meet the following criteria:

- Certified according to UNECE Regulation 46 for all relevant CMS FOV.
- CMS FOVs shall be adjusted by the manufacturer to provide drivers with the relevant FOVs and shall subsequently only be adjusted by trained personnel.
- Images for the offside and nearside FOV shall be presented on the respective side of the driver's ocular reference point.
- The offside CMS monitor shall be located at either Position 1 (on the offside A-Pillar) or Position 2 (inside the offside A-pillar), as illustrated in Figure 4_2, with Position 1 the preferred location.
- The nearside CMS monitor shall be located between Position A (at the centre-top of the windscreen inside the driver cab), Position B (inside the nearside A-pillar) and Position C (on the nearside side console inside the driver cab), as illustrated in Figure 4_2, with Position A the preferred location.
- CMS monitors shall be located such that they do not affect the driver's direct field of vision (FOV). When evaluating the direct vision performance of the bus according to the bus enhanced direct and indirect vision standard (see 4.3.7), there shall be no change in the direct vision performance score (DVS) both with and without the CMS monitors installed in their operational positions.
- CMS monitors shall not be located lower than 30 ° below a horizontal plane passing through the driver's ocular reference point.

- CMS monitors shall not be located at an angle greater than 55° from a vertical plane formed by the ocular reference point and the neck pivot point (located 98 mm rearward from the ocular reference point in the X axis, see 4.3.7) when rotated in both directions about the neck pivot point.
- Maximum CMS monitor distance from the nearest point of the monitor to the driver's ocular reference point shall be no greater than – Offside: 1.7 m | Nearside: 2.6 m.

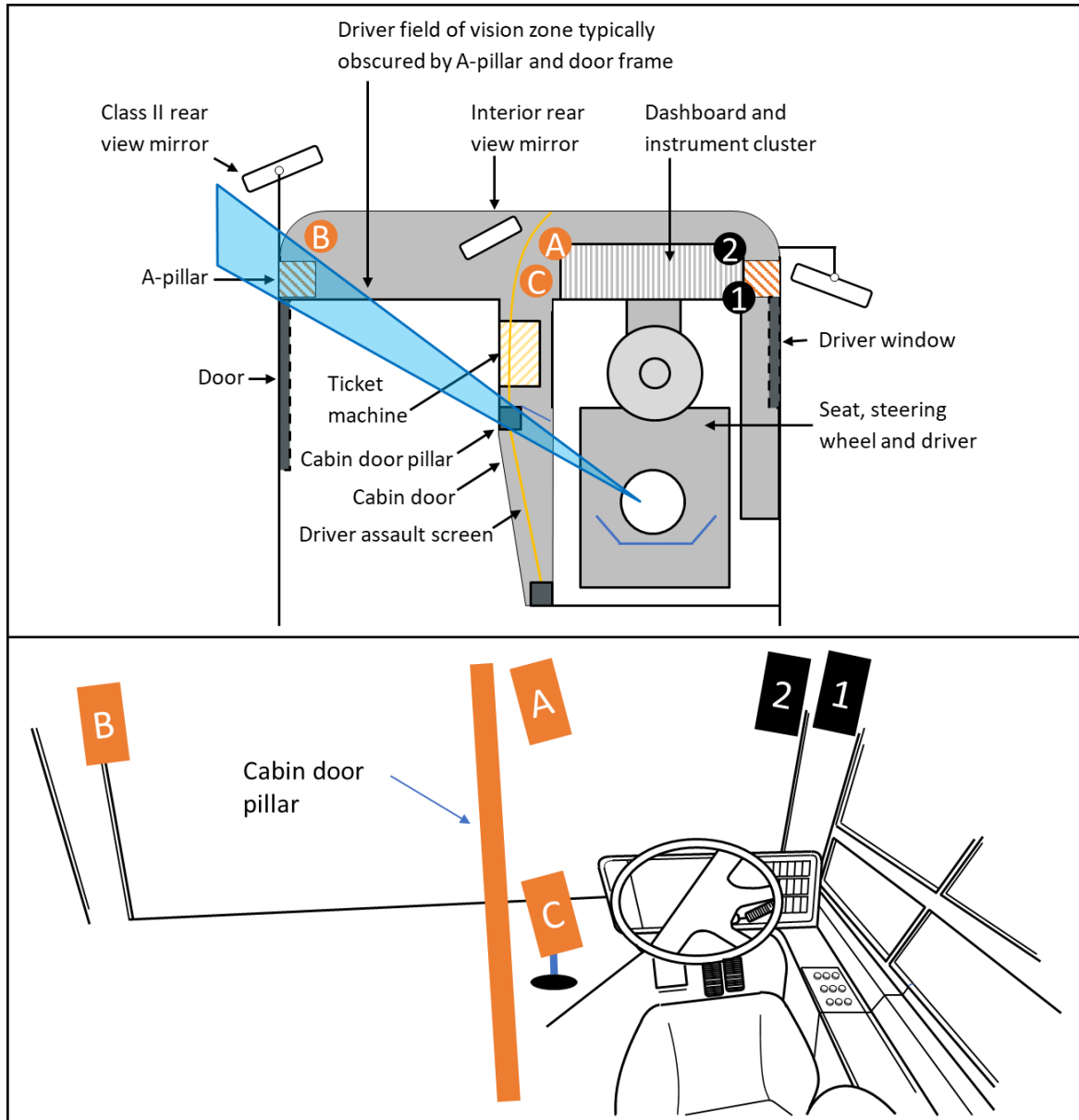


Figure 4_2. Recommended offside (1-2) and nearside (A-C) CMS monitor positions

- Minimum CMS monitor distances from the nearest point of the monitor to the driver's ocular reference point shall be no less than 0.5 m.
- Minimum magnification factors, as evaluated in UNECE Regulation 46, for the Class II monitor shall be at least – Offside: 0.26 | Nearside: 0.13.



- Average magnification factors, as evaluated in UNECE Regulation 46, for the Class II monitor shall be at least – Offside: 0.31 | Nearside: 0.16.
- Minimum magnification factors, as evaluated in UNECE Regulation 46, for the Class IV monitor shall be at least – Offside: 0.054 | Nearside: 0.016.
- Average magnification factors, as evaluated in UNECE Regulation 46, for the Class IV monitor shall be at least – Offside: 0.091 | Nearside: 0.046.
- Non-continuous images on the monitor shall be clearly separated.
- The driver's view of the monitor shall not be obstructed by components with a transmittance of less than 70 %.
- The driver's view of the monitor shall not be obstructed by internal bus glazing with an Angle of Incidence (AOI) of greater than 70 ° to the driver's sightline, when evaluated according to the enhanced direct and indirect vision standard (see 4.3.7).
- CMS monitors shall not obstruct any internal mirrors used for driver visibility of the saloon or wheelchair bay.
- Driver vision of monitors shall not be obstructed by communication holes in driver assault screen.
- Ambient light (e.g. sunlight and artificial light) illuminating the monitor shall be minimised as far as reasonably practical.
- Reflections on bus glazing as a result of the monitor shall be reduced as far as reasonably practical.
- Monitor vibration shall be minimised as far as reasonably practical, with monitor images interpretable up to 90 % of maximum design speed.
- CMS components shall not be located within 5 cm of any radio device emitting electromagnetic radiation in a frequency range that would interfere with the operation of the CMS.
- CMS shall remain fully operational between temperatures of -10 °C and +40 °C with no reduction in image quality
- Driver CMS familiarisation training shall be provided to all drivers and shall include nearside peripheral vision awareness training for nearside monitors positioned in a different location to the traditional nearside external mirror.
- Eye examinations shall be regularly performed for drivers, in particular looking for presbyopia issues which affect eyesight "accommodation" (i.e. the ability of the driver to switch between different viewing distances, which is associated with a decline with age). Corrective lenses, such as bifocal or progressive lenses, shall be provided to drivers that require support.
- The CMS shall be protected from tampering.

The bus OEM or, where installed as a component on an existing vehicle, the CMS supplier, shall provide documentary evidence of compliance with these requirements.



4.3.4.5 Front & Nearside Blind Spot Warnings

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

All buses shall provide additional information to drivers to inform them about the potential hazards presented by vulnerable road users in close proximity to [the front and nearside of] the bus, or intervene if necessary, to support the safe execution of the low speed, close proximity, driving tasks required in service in London.

All buses shall have a system installed that informs the driver of the presence of vulnerable road users in close proximity to the front and nearside of the bus, provides a warning signal to the driver if the bus is on a collision trajectory with a vulnerable road user during nearside-turn and moving-off manoeuvres and/or intervenes if a collision is unavoidable during moving-off manoeuvres.

The installed system shall have one or more of these functions:

- VRU proximity information signal
- VRU collision warning signal
- Motion inhibit

All buses shall be assessed in accordance with LBSL's Blind Spot Warning Assessment Protocol (Attachment 24), reporting the BSW performance score for each bus model or bus model variant (as appropriate). Each bus must achieve a score of [60] % or more.

The bus OEM or, where installed as a component on an existing vehicle, the Blind Spot information, Warning and intervention system supplier, shall provide documentary evidence of compliance with these requirements.

4.3.5 Pedal Application Error

TfL are currently conducting further research and assessment of data taken from service conditions to develop the requirements, assessment protocols and guidance notes for Pedal Application Error and ensure their suitability. As such this section provides the current expectations, it is however subject to change.

4.3.5.1 Footwell camera

A camera shall be installed in the driver footwell area to provide full and uninterrupted coverage of brake and acceleration pedal operation.

The footwell camera shall:

- Maintain good image quality under all lighting conditions, including the capability of operating in "zero lux" conditions (e.g. using infrared if necessary)
- Have a minimum IP65 rating
- Be integrated into the main CCTV recording system to maintain security water marks, consistent time code, date stamp, and bus information (speed, location, and fleet number)
- A separate standalone camera with internal memory card is not permitted



4.3.5.2 Accelerator Light System (ALS)

This is a driver aid intended to help prevent pedal misapplication and may help recovery from a pedal confusion event. The system has no control over vehicle trajectory or velocity. It does not absolve the driver of responsibility for following safe driving procedures and pressing the correct pedal at all times.

A light-based visual indicator shall illuminate when the accelerator pedal is positioned at >80 % of maximum demand.

The light shall be in a suitable location such as the dashboard or an LCD information screen.

The light shall be large enough, so it is clearly visible from the driver's seat.

The light shall not negatively affect the driver's direct or indirect vision of the road, the cabin or the interior of the bus.

The accelerator light shall be designed and installed such that:

- maintenance and repair is as convenient as possible.
- it complies with to the requirements set out in UNECE Regulation 121. This makes reference to ISO 2575:2004, which should be used as additional guidance if needed. If further guidance is still needed, then the guidance set out in the NHTSA Human Factors Design Guidance For Driver Vehicle Interfaces (DOT HS 812 360) may be referenced as a third option. UNECE Regulation 121 takes precedence in all cases.

The icon presented in Zone A of the bus dashboard must be identical to the icon presented below:



Figure 4_3. Pedal indicator icon design

- The icon must be displayed on a minimum pixel matrix of 32 x 32.
- The icon shall be yellow on a black background.
- All text must be presented on a minimum character matrix of 7 x 9.
- The icon shall not flash or flicker.

- The font of the text is not specified but must be clearly legible (ISO 2575:2010+A7:2017).
 - The text spacing should adhere to the following guidance from ISO 15008:2017: Typefaces selected should be evenly and proportionately spaced.
 - The space between vertical strokes (such as between l and m) should range between 150 % and 240 % of the character stem width.
 - The space between diagonal characters and a vertical (such as between v and l) should be a minimum of 85 % of the stem width (Figure 4-3).
 - Two diagonal characters should not touch.

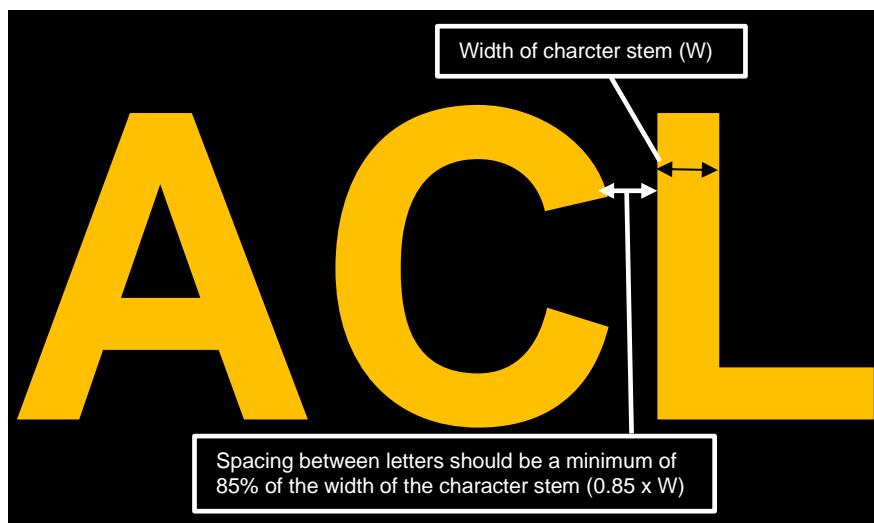


Figure 4-3 Letter spacing

The system must be fully integrated by the bus OEM. Post vehicle homologation fitment of aftermarket equipment is also permitted as long as the work is undertaken by the bus OEM.

Information on the position of the accelerator pedal shall be taken from existing on-board sensors via the CAN bus, or some other suitable signal input with an accuracy of $\pm 1\%$. (i.e. 80 % accelerator pedal depression $\pm 1\%$).

Any delay between the moment at which the pedal exceeds an application of 80 % $\pm 1\%$ and the lamp achieving a steady state output which is perceivable by human eye, as a consequence of either delays in electrical transmission of the signal or in terms of the lamps ability to respond quickly to that signal, shall be sufficiently small as to appear instantaneous to the driver.

The Pedal use indicator lights shall

- operate automatically without the need for the driver to activate or deactivate the system.
- operate in all driving scenarios.



- be tested according to the protocol defined in Attachment 26 and be certified as a “Pass”.
- have no adverse effects on other vehicle operations and systems.
- not distract the driver from completing their driving tasks.
- illuminate one uniform colour whenever accelerator pedal position is >80 % of maximum
- not illuminate at a position of ≤80 % of maximum accelerator pedal position
- Activate regardless of whether the bus is in Neutral, Drive, or Reverse gear.

Only a qualified and authorised engineer shall be able to disable the system following the procedure set out by the vehicle OEM. It should be possible to shut down the system through a laptop connected to the vehicle.

It shall only be possible to disable the system when the bus is stationary, with the engine switched off and the ignition on.

The system is a driving safety aid. It will be perfectly feasible for a careful and competent driver to drive the vehicle safely without this assistance. As such, a system failure shall not be deemed to render the vehicle unroadworthy (subject to any change in regulation). The system shall be checked as part of the regular maintenance checks.

An audible indicator would be considered by TfL, subject to submission of an example, description of implementation, testing evidence, and quantification of effectiveness. This would only be considered as an addition to the light indicator, not as a replacement.

4.3.5.3 Brake toggle system

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

The brake toggle system is intended to provide a regular refresh of the driver's memory of the use of the brake pedal. The system aims to help prevent pedal misapplication and may help recovery from a pedal application error event. The system has no control over vehicle trajectory or velocity. The driver is ultimately responsible for pressing the correct pedal at all times.

The system is intended to ensure that the brake pedal must be depressed and then released before the bus can pull away from stationary for the first time since the Halt Brake was applied (see Section 4.3.7) or the park brake being applied (whether by the driver or as part of Runaway Bus Prevention; See Section 4.3.6).

The pedal deflection shall be sufficient to trigger the brake lights coming on.

The system must be fully integrated by the bus OEM.

The system shall be integrated with the vehicle's CAN bus, or other suitable information transmission system, so that it can receive the required real-time information on the position of the brake pedal. The signal shall be accurate to ±1%.

The Brake Toggle System shall:



1. Operate automatically without the need for the driver to activate or deactivate the system.
2. Be capable of operating in all driving scenarios.
3. Be tested in accordance with the protocol defined in Attachment 26 and achieve a score of 14 (Drive score = 7, Reverse score = 7).
4. Have no adverse effects on other vehicle operations and systems.
5. Ensure that the Halt Brake will release no more than 500 ms, only after the following 2 conditions have BOTH been performed chronologically:
 - I. The brake pedal is depressed enough to trigger the brake lights coming on and then released.
 - AND
 - II. The accelerator pedal is depressed by > [10 %] within [10] s after releasing the brake pedal.

As such, the vehicle shall be incapable of movement until both steps I and II have been successfully completed.

6. Reset the Halt Brake to a 'no drive allowed' condition if the driver does not apply a depression of > [10] % to the accelerator pedal within ≤ [10] s after releasing the brake pedal. This will require the driver to undertake steps I and II again, in order to release the Halt Brake.

NOTE: The Halt Brake symbol shall illuminate green when the Halt Brake is in a 'drive allowed' condition and Red when the Halt Brake is in a 'no drive allowed' condition

Only a qualified and authorised engineer shall be able to disable the system following the procedure set out by the OEM. It should be possible to shut down the system through a laptop connected to the vehicle.

It shall only be possible to disable the system when the bus is stationary, with the engine switched off and the ignition on.

The driver shall be warned of a system failure through the activation of a red warning light on the dashboard, and the halt brake light will be sufficient for this purpose.

[TfL are currently conducting further assessments to define a standardised halt brake red warning light, which may be included in a future issue of this document]

Any fault with the system shall log a diagnostic trouble code in a suitable memory system at least while the fault is active and preferably for a significant period of time after the fault is active unless manually cleared.

4.3.5.4 Pedal acoustic feedback system

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

An audible accelerator pedal feedback system should be fitted to quiet running vehicles to provide an audible cue to avoid pedal confusion. Vehicle speed can lag



behind pedal demand, so this will likely need to be a different sound to the AVAS Regulation 138 sound described in section 4.4.1 and is external to the vehicle.

The goal will be to have one sound common across all models in order to reduce the risk of confusion between models for drivers.

[TfL are currently conducting further research and assessment to define a specific sound for the Pedal acoustic feedback system. Once agreed this will be made available from TfL upon request.]

The following requirements apply:

- The feedback system shall have a master volume control that can only be set by the bus OEM to prevent increasing the noise levels inside the saloon of the bus.
- The level set by the OEM shall be audible by the driver and not cause undue annoyance. (Levels to be defined by testing using ISO 5128 -1980 (E); Acoustics - Measurement of Noise inside Motor Vehicle).
- A local Driver volume control shall also be incorporated that will allow the driver to reduce the volume of the system to a pre-set minimum level (not to switch off) and also not increase the volume beyond the OEM pre-set point.
- The feedback speaker(s) should be mounted behind the driver's head area at ear height.
- When installing/positioning the feedback speaker(s) care must be taken as to not have a detrimental effect on head movement during the operation of the bus and in the case of a collision the head being able to strike hard objects.

Note: Consideration should be given to the utilisation of existing equipment, such as speakers already fitted to the bus, which could be beneficial in reducing the amount of equipment around the driver's head.

4.3.5.5 Pedal Standardisation

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

4.3.5.6 AEB logic

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses



4.3.6 Runaway Bus Prevention

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

The runaway bus prevention system will not replace the halt brake but instead will work in conjunction with it to automatically stop the bus from moving from a stationary position in the event that a driver is not present in the driving seat (see section 4.3.6.1 below) and the park brake has not been applied.

The system shall be tested in accordance with the assessment protocol defined in Attachment 28 and meet the pass criteria detailed in Attachment 28 – section 8 and 9.

4.3.6.1 Driver Detection Requirements

Primary Inputs

Primary inputs are signals broadcast at a high refresh rate that can only be triggered by the driver directly (either by use of hand or foot). They are:

- Accelerator Pedal input
- Brake Pedal Input
- Park Brake

For Primary Status to be 'Driver Detected', a minimum 1 of 3 signals must be in a TRUE or changing state i.e. the driver is applying or lifting their foot off the brake or accelerator pedal

NOTE: for vehicles with a creep function, this does not qualify as a Driver Detection Accelerator input, only physical application of the Accelerator Pedal qualifies as a Driver Detection Input.

Secondary Inputs

Secondary inputs are signals that may change due to non-driver influences (vibration, low accuracy sensors, etc.). They are:

- Driver's cab door sensors
- Driver's seat pressure sensor
- Steering wheel angle

For Secondary Status to be 'Driver Detected', minimum 2 of 3 signals must be in a TRUE or changing state i.e. the Driver's Cab Door is closed and the driver is sitting in their seat, but the driver is not turning the steering wheel

- When Primary or Secondary Status is 'Driver Detected', this indicates that the driver is present in the drivers cab/seat and in control of the vehicle according to that Input.
- When a Primary or Secondary Status is 'Driver NOT Detected' then the Driver is not Present OR not using the vehicle in a safe manner (e.g. driving with the Driver's Cab Door open, or driving while not in their seat).



If some other means to identify the driver presence in the cab is technically preferable by an OEM then this must be submitted with evidence and schematics for consideration by LBSL.

Any deviations from the prescribed system and assessment protocol requirements must be documented AND agreed in writing by TfL, and added to the test report as an addendum. Any system tested without TfL's prior written approval shall be deemed to be NOT compliant.

4.3.6.2 System Operation

The Runaway Bus Prevention system shall function such that it satisfies all of the following conditions:

- Ideal Operation – The Runaway Bus Prevention system may operate in conjunction with the Halt Brake such that when the conditions to activate application of the Halt Brake or Park Brake are met:
 - The Halt Brake application shall be triggered $\leq [0.5]$ s after Trigger Conditions are met
 - The Park Brake application shall be triggered $\leq [0.5]$ s after Trigger Conditions are met
 - The vehicle shall come to rest $\leq [1]$ s after Trigger Conditions are met
- Failsafe Operation - The Runaway Bus Prevention system shall operate in a condition without use of the Halt Brake such that when the conditions to activate application of the Park Brake are met:
 - The Park Brake application shall be triggered $\leq [0.5]$ s after Trigger Conditions are met
 - The vehicle shall come to rest $\leq [2]$ s after Trigger Conditions are met
- Audible Operation – When the vehicle speed is > 5.5 km/h AND the conditions to activate application of the Park Brake are met:
 - The system shall trigger an audible warning to the driver $\leq [0.5]$ s after Trigger Conditions are met

4.3.6.3 System Hierarchy

Following the below hierarchy, the system shall:

1. Act in accordance with the System Operation (section 4.3.6.2 above), using both the Park Brake and the Halt Brake. There shall be minimal opportunity for vehicle roll when Runaway Bus Prevention triggers application of the Park Brake while also ensuring that it is not possible for air leakage over time to result in bus movement.
2. Either trigger application of the Park Brake if the driver attempts to switch the vehicle off without first applying the Park Brake, or prevent the driver from switching the vehicle off until they have applied the park brake.
3. Activate application of the Park Brake according to the following manners dependent on the vehicle speed condition:



- i. Not activate in a situation where the bus is already intentionally in motion (moving > [5.5] km/h). In this condition the system shall trigger an audible alert
 - ii. Activate application of the Park Brake in any situation where the bus is stationary or moving at a speed of \leq [5.5] km/h.
4. Activate application of the Park Brake or the Audible Alert (determined by Point 3 above) immediately if **ANY** of the following Driver Not Detected Trigger Conditions are met:
- o All monitored Primary **AND** Secondary Status Signals show INACTIVE for a period of [0.5] s
- OR**
- o Primary Status is Driver Detected for the previous [1] s window **AND** Secondary Status is Driver NOT Detected for the previous [3] s window
- OR**
- o Primary Status is Driver NOT Detected for the previous [5] s window **AND** Secondary Status is Driver NOT Detected for the previous [1] s window
5. Require Brake toggling to release under normal use conditions (see Section 4.3.5.3)

NOTE:

- i. All signals required to determine driver presence as per the conditions in point 5 and Section 4.3.6.1 must be monitored at all times.
- ii. A window is defined as the rolling time period defined in seconds in point 5
- iii. A Driver Present condition is considered to be met when both the Primary and Secondary status windows show the requisite logic (Driver Detected or Driver not detected) and overlap as per point 5
- iv. If the conditions to trigger activation of the park brake via Runaway Bus are met while the vehicle is travelling at > [5.5] km/h and the vehicle subsequently reduces speed to \leq [5.5] km/h while the conditions to trigger activation are still met, then the park brake shall be activated immediately.
- v. If the conditions to trigger application of the Park Brake have been met and application of the Park Brake has been initiated, no change in vehicle speed OR Driver Detection status will prevent the Park Brake from being applied

4.3.6.4 Vehicle Creep Function

If a vehicle has functionality to allow creep, it shall undergo a supplementary set of tests to ensure that in reasonable driving conditions, any creep function shall not cause the vehicle to travel at a speed > [5.5] km/h and not interfere with the correct functioning of the RaBPs.

Vehicle creep does not qualify as a Driver Detection Accelerator input, only physical application of the Accelerator Pedal qualifies as a Driver Detection Input.



4.3.6.5 Auxiliary Release (RaBPS Kill Switch)

Should a failure be detected in any element of the system while the runaway bus prevention system has already (correctly) activated the park brake, it shall continue to apply the park brake until such time that a qualified person activates or permits activation of the auxiliary release mechanism in order to safely release the bus.

Activation of the Auxiliary Release mechanism shall not require any movement of the vehicle.

The Auxiliary Release switch shall not be positioned in a location that is obvious or allows easy usage by the driver

- This may include requiring a sequence of events to activate the Auxiliary Release, or location of the switch behind a panel not situated within the driver’s cab

In the event of a sensor failure that would cause the runaway prevention system to render the vehicle immobile (despite the fact that a runaway bus event is not in progress) the auxiliary release system should be engaged to disable the system and allow the bus to return to the depot to have the sensor repaired/replaced. System checks shall be included in the regular maintenance checks.

The Auxiliary Release system shall deactivate once vehicle is switched back on, after being switched off.

Table 4_2 Auxiliary Release Ignition Cycle Process

Vehicle Ignition State	Auxiliary Release State
On	Auxiliary Release applied while vehicle is on
Off	Auxiliary Release remains applied once vehicle is switched off
On	Auxiliary Release deactivates automatically once vehicle is switched back on

4.3.7 Halt Brake

The halt brake shall be engaged whenever the bus doors are opened, the bus is kneeling, or the passenger ramp is extended and the Driver is present in the cab (as defined in section 4.3.6.1).

Once the Halt Brake has been activated the bus shall remain stationary until both:

- The Primary and Secondary ‘driver present in cab’ conditions for Runaway Bus prevention are met (see section 4.3.6)

AND

- The driver has performed Brake Toggling correctly (see section 4.3.5.3)

The system shall be checked as part of the regular maintenance checks. If a fault occurs with the halt brake system, rendering it inoperable, then a red warning light shall activate. System checks shall be included in the regular maintenance checks.



[TfL are currently conducting further assessments to define a standardised halt brake red warning light, which may be included in a future issue of this document.]

4.3.8 Tyre Pressure Monitoring Systems (TPMS)

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

All buses shall be equipped with a Tyre Pressure Monitoring System (TPMS), compliant with 01 series of amendments to UNECE Regulation 141, for the approval of vehicles with regard to their TPMS.

If vehicle already is equipped with either:

- A Tyre Pressure Refill system (TPRS)
- OR
- A Central Tyre Inflation System (CTIS)

Then, shall it be deemed to be equivalent to having a Tyre Pressure Monitoring System (TPMS) when the test criteria of Annex 4, 01 series of amendments to UNECE Regulation 141 are met. In this case TPMS is not required to be installed.

The TPMS fitted to a bus provides information to the driver when a loss of pressure occurs in a tyre, by illuminating the indicator light on the dashboard. The TPMS is a driver's aid and does not remove the requirement for maintenance of wheels and tyres.

There are two acceptable TPMS systems:

- i. Direct system - Consists of a TPMS sensor installed directly on to the valve of each wheel. These sensors send information relating to the tyres pressure and temperature in near real time through to the vehicle's Electronic Control Unit (ECU) via Radio Frequency (RF) signals which triggers the illumination of the dashboard indicator light.
- ii. Indirect system – The system uses the vehicle's Anti-lock Braking System (ABS) sensors to calculate the rate at which each wheel rotates, therefore determining if a tyre has a reduction in pressure in relation to the other tyres. If a tyre's pressure is low, it will cause the wheel to roll at a different speed to the other wheels. This information when detected by the ECU, will trigger the illumination of the dashboard indicator light



The OEM shall provide documentary evidence of TPMS test results for each of the following:

- Puncture test
- Diffusion test
- Malfunction test

If vehicle is fitted with TPRS or CTIS then the OEM shall provide documentary evidence of test results for both:

- Refill functionality
- Malfunction warning

Tests assessing the performance of Tyre Pressure Monitoring Systems fitted to new buses must be undertaken according to 01 series of amendments to UNECE Regulation 141.

4.3.9 Alcohol Interlock Installation Facilitation

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

All new buses shall be equipped with the Alcohol Interlock Installation Facilitation. The OEM is required to provide standardised connector facilitation with the installation document for the aftermarket installation of an Alcohol Interlock into vehicle. For this purpose, Alcohol Interlocks are connected to the electric and control circuits of the vehicle.

The OEM is required to provide standardized installation documents in paper or electronic versions, with all necessary relevant information for the technicians installing an Alcohol Interlock into a vehicle, according to EN 50436-7 Alcohol Interlocks – Test methods and performance requirements.

The installation document must contain as a minimum the following:

- Connection schematics – specifying three interfaces to support Alcohol Interlock installation:
 - Classic installation
 - Pseudo-digital installation
 - Digital installation according to EN 50436- 4
- Safety risk at installation and items to be considered
- Assembly instructions
- Modification of vehicle operation
- Mounting position of alcohol interlock handset and the alcohol interlock control-unit



4.4 Partner Assist

4.4.1 Acoustic Conspicuity

All quiet running buses of category M3 are to be fitted with a front emitting Acoustic Vehicle Alerting System (AVAS) which is fully compliant with UNECE Regulation 138. This includes electric, hybrid and other alternative powertrains that are quiet running. This is required even if the bus already meets the minimum sound requirements of Regulation 138 without the AVAS; an AVAS sound is required on all buses to achieve a uniformity of sound across London.

This specification applies to Existing Fleet Vehicles, Retrofit Vehicles (as defined in the Retrofit programme) and all New Build Vehicles. Performance standards may vary depending on the vehicle category as defined in this document and attachments.

TfL has designed a unique Urban Bus Sound to be used for AVAS on quiet running buses in London and buses belonging to other organisations at TfL's discretion.

4.4.1.1 System Performance

The Urban Bus Sound consists of two components, the Core sound and the Beacon sound. TfL will provide Wave (.wav) files containing these components. Playback of the two sound components must be representative of the original files: retaining the same relative amplitude and the same frequency equalisation in all specified operating conditions to comply with this standard.

The Core sound shall be played at all times on bus start up, including when stationary.

The Beacon sound is to be played whenever the bus is in motion regardless of whether the bus is moving forwards or backwards. The Beacon sound shall continue playing until the vehicle comes to a stop.

Seamless transition between the Core and Beacon sounds shall be achieved through synchronised playback of the two Wave files.

The reversing operation requirements of Regulation 138 are to be achieved by means of either the sounds produced by the vehicle when reversing or by an AVAS that operates using the Urban Bus Sound. This is in addition to any reversing alarm requirements.

4.4.1.2 Sound Amplitude

When the Core sound is playing the AVAS must achieve the sound levels ($L_{MAX,FAST}$) defined in Attachment 30, Appendix B when measured at the positions outlined.

When both the Core and Beacon sounds are playing the AVAS must achieve both the sound levels ($L_{MAX,FAST}$) defined in Attachment 30, Appendix B when measured at the positions outlined, as well as meet the minimum requirements set in Appendix 3 of UNECE Regulation 138.



<p>Responsive AVAS (Geo-fencing)</p>	<p>For speeds up to 22 km/h the amplitude of the Urban Bus Sound will be determined by the location of the bus as well as the time of day. This is to be achieved through the AVAS interfacing with the ISA system, which will set the appropriate AVAS Step level profile defined in Appendix B (Attachment 30) between 0 and 22 km/h. AVAS Step level profiles range between 1 to 4.</p> <p>The amplitude shall transition smoothly between roads, taking no more than 3 seconds to transition from one step level profile to another.</p>
<p>Non-Responsive AVAS (For Existing Fleet and Retrofit programme vehicles without ISA capability only)</p>	<p>For speeds up to 22 km/h the amplitude of the Urban Bus Sound will be set to AVAS Step level 3 profile defined in Appendix B (Attachment 30) between 0 and 22 km/h.</p>

From 22 km/h the sound must attenuate, decreasing linearly so that the AVAS stops sounding at 28 km/h.

At all times, the Driver’s Cabin must not be exposed to sound levels above those set out in Attachment 30, Appendix B, as a result of sound from the AVAS. Manufacturers are encouraged to further reduce the level of sound ingress to the Cabin from the AVAS through system configuration, placement, equipment, sound insulation, or other means, below the maximum levels set out in Attachment 30.

4.4.1.3 Frequency Modulation

The pitch of the Urban Bus Sound must increase at a rate of 0.8% per km/h, for the full speed range of operation, as the bus accelerates and decrease at the same rate as the bus decelerates.

4.4.1.4 Frequency Profile

The AVAS shall be capable of shaping the frequency content output by the sounders in order to achieve the desired frequency profile. This can be implemented either as a hardware or software component of the system.

The Urban Bus Sound must achieve the minimum frequency profiles defined in Attachment 30, Appendix B for when the vehicle is stationary and when it is moving at the measurement positions outlined.

Sounder technologies for harsh operating environments are continually evolving. Manufacturers are encouraged to develop enhanced frequency response at low and



high frequencies for suitable weatherproof sounders in order to improve fidelity of the Urban Bus Sound operating across the TfL bus fleet. The minimum frequency profile in Attachment 30 shall be updated at regular intervals to respond to improvements in weatherproof sounder performance and improve fidelity of the Urban Bus Sound operating across the TfL bus fleet.

4.4.1.5 AVAS Hardware Requirements

All AVAS sounders shall be selected for their suitability in terms of achieving the specified performance and for their ability to withstand the environment in which they are located (including protection against ingress of liquids and solids, corrosion/oxidisation/erosion, vandalism, heat/fire resistance). The AVAS sounder(s) shall be rated to IP67 standard or above and located in the area defined in Figure 4-4.

The system hardware shall be E marked to meet current automotive EMC standards.

A complete functionality self-check of the AVAS must take place on bus start-up, testing hardware and software functionality. The self-check duration and notification shall take no more than five seconds to complete. The system shall provide the driver with a notification that it is operative and free of defects. The Driver shall be informed should the AVAS fail at any time while the bus is switched on by means of a notification. Careful consideration must be given to both the layout to ensure an ergonomical design, and choice of audio/visual alerts/notifications used, to reduce driver movement and conflicts with other audio/visual systems used.

Responsive AVAS systems shall incorporate a failure mode to allow it to operate at the AVAS Step level 3, as set out in Attachment 30, Appendix B, in the event that external signals necessary for setting the output amplitude are not received. The UN ECE Regulation 138 requirements shall be maintained at all times.

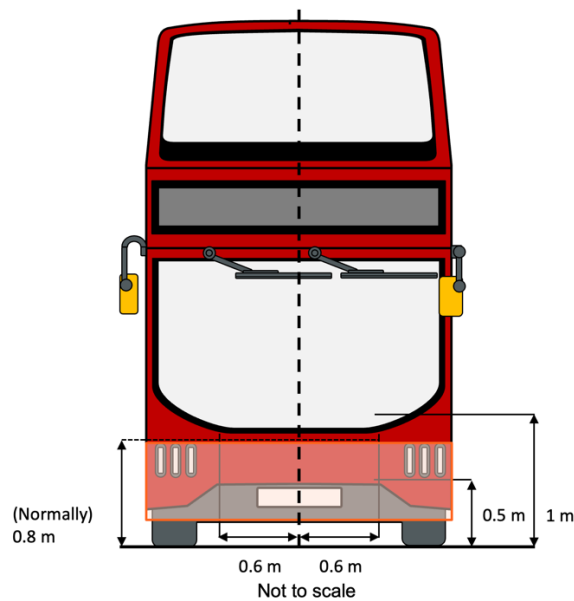
It shall be possible for TfL or the bus operators to upload new sounds into the AVAS hardware, either remotely or with minimal intrusion of the bus so as to prevent buses being unnecessarily taken out of service.

All sound reproduction shall be of a good quality and free from system noise including audible artefacts such as clicks, gaps, hum, distortion effects or clipping. Audio cables shall be separated and suitably shielded from control and power cabling to avoid audible artefacts.

Sounder(s) shall be positioned at the front of the vehicle as a minimum, in the area noted in Figure 4_5. Sounders shall be positioned in the direction of travel and not be obstructed by any solid covering in order to optimise sound projection and directionality (to achieve this, apertures, grilles, perforated front panelling or other aperture types are acceptable), this shall be done while maintaining the sealing integrity of the front of the vehicle. *Any requirements for apertures, grills, perforations, or other aperture types to the front panelling only applies to New Build vehicles.*

Sounders shall be mounted using appropriate anti-vibration fixings, in order to reduce structure-borne vibration into the Driver's cabin.

Sounder locations are to be selected by the manufacturer to comply with regulatory and Attachment 30 requirements.



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Figure 4_5 Area at the front of the vehicle that must include at least one AVAS sounder to meet regulatory and Attachment 30 performance requirements

The AVAS shall be assessed according to Attachment 30 and be shown compliant.

4.4.2 Visual Conspicuity

The housings for driver's nearside and offside mirrors shall be coloured yellow in their entirety.

No additional warnings or markings shall be present on the all-yellow mirror head.

4.5 Occupant Protection

4.5.1 Staircase

Double-deck buses must have a forward ascending 9-step straight staircase with a step tread depth not less than 230 mm, and a step riser of not more than 245 mm located as on the agreed bus layout drawings in Attachment 8.

Handrails must be provided to both sides of staircase, continuous throughout its profile, with no potential hand traps.

An additional offside (body panel side) horizontal handrail on the staircase is required, to improve passengers' handhold options when using the staircase. Attachment 8 shows a typical arrangement as an example.

Exposed butt ends to handrails are not permitted anywhere on the staircase or its access.

Headroom throughout the staircase should be sufficient to minimise risk without the need to provide impact protection.



Finishing edges shall be high quality moulded covers that cope with high passenger volume operation

If transparent materials are used to provide the aisle side staircase panel in the lower salon, it should be of obscured material to achieve a decency screen for staircase users.

If interior panel / corner finishing is utilised, it should be of suitable quality / standard to cope with high wear operation, and if damaged, should not present an immediate increased safety risk.

4.5.2 **Seats**

Tip up seats are not generally permitted anywhere on the bus. However, these will be considered by LBSL where they can demonstrate an improvement in safety and/or customer experience.

Seats should be forward facing, except where the chassis design function over wheel boxes necessitates inward or rearward facing.

4.5.3 **Handrail/stanchion construction and installation**

All handrails and stanchions shall be constructed such that they meet UNECE Regulation 107 and PSVAR2000 and form a smooth tube of between 30 mm and 35 mm in diameter and finished in powder coating or nylon dipped (both with a matt crackle finish). Handrails and Stanchions should be coloured, yellow (RAL 1028), green (RAL 6018) or orange (RAL 2028). Any alternative colours will require the prior approval of the Nominated Officer.

Staircase handrails shall be of identical cross section to the main saloon handrails

A longitudinal waist height handrail shall be provided, forming a continuous passenger waist height hand grip support from the front passenger door entrance / driver cab area to the beginning of the passenger seated area or staircase steps.

Door partition handrails, positioned to assist boarding and alighting, must be fitted at all entrance and exit points, excluding emergency exits.

Seat back to ceiling handrails (with bell push) are required at all forward facing seat pairs in the lower saloon. In the upper saloon, either seatback to ceiling handrails or a suitable alternative (handgrabs in highback seats etc.) are required at alternate seat pairs as a minimum. On both saloons, where bell pushes are integrated into seatbacks, there shall be a minimum of one bell push per seat pair.

All bell push buttons shall be coloured red with surrounds coloured such that they contrast with both the red bell push and the hand poles, whatever their colour.

Where horizontal handrails are fitted in standing areas, bell pushes, as described above, must be placed in a position so as to limit the risk of accidental activation by passengers leaning on them.

Horizontal rails above the wheelchair and/or standing areas to be fitted with hanging grab hand holds of the flexible type. These grab hand holds shall only be used in the low floor area and must not be placed in entrance / exit doorway areas.



4.5.4 Guards for exposed seats

Guards for exposed seats shall be fitted as per the performance requirements where any seated passenger is likely to be thrown forward into a designated wheelchair space, buggy (pram) space, or open area for standing passengers as a result of heavy braking, as specified in the 06 series of amendments for UNECE Regulation 107.

Note: The UK DfT proposed this amendment which was adopted as part of the 06 series of amendments, supplement 5. For vehicles approved following EC whole vehicle type approval (ECWVTA), it is expected that these amendments will be mandatory circa 2020. Previously, Regulation 107 specified that guards must be fitted for exposed seats behind step wells, only.

Guards for exposed seats shall:

- have a minimum height from the floor on which the passenger's feet rest of 800 mm and shall extend inwards from the wall of the vehicle at least as far as 100 mm beyond the longitudinal centre line of any seating position where the passenger is at risk.
- be enclosed (i.e. the size of any aperture shall not exceed 50 mm) and the lower edge of the guard shall not be more than 100 mm from the floor on which the passenger's feet rest.

4.5.5 Bus Interior Safety Assessment

Level 1 requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

Level 2 requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

Bus interior safety shall be assessed according to the protocol defined in Attachment 34. Assessments shall be undertaken for each bus model / variant in a service ready condition.

The bus interior safety assessment score counts potential hazards. Thus, a bus with a lower score, with less potential hazards, is better. Two levels of safety are considered. To be certified as meeting level 1, then the bus must achieve a score of:

- Lower deck \leq [80]
- AND Upper deck (if applicable) \leq [8].

Note: Main changes anticipated are in the middle door area including incorporation of guard in front of seats behind wheelchair area and modifications to guard for seats behind middle doors.

To be certified as meeting requirements level 2, then the bus must achieve a score of:

- Lower deck \leq [30].
- AND Upper deck (if applicable) \leq [4].



Note: Main changes anticipated are throughout the whole bus to achieve an improved rating for handrails, restraint and general hazards. Improved restraint is also likely to require fitment of some seats with higher backs.

4.5.6 Flooring and Slip prevention

The following requirements apply:

- Floor coverings shall have joints minimised.
- Colour contrasting step nosing shall be used on all step edges in accordance with the PSVAR2000.
- There should be no cross hatching (or any other marking) of the floor area rear of the “Do not stand forward of this point” sign.
- There shall be no cross hatching (or any other marking) of the floor area forward of the “Do not stand forward of this point” sign.
- Slip resistant flooring shall be fitted throughout passenger saloon area.
- The slip resistance of flooring material shall be characterised under wet conditions
- Slip resistance shall be measured at the same location in up to three directions, separated by 45 ° increments as specified in the assessment protocol (Attachment 32).
- All flooring material types, at the point of entering service, shall provide a minimum slip resistance. The material will be deemed a failure if the mean Pendulum Test Value (PTV) is found to be less than 36.0.
- All flooring material types, after approximately 100,000 passengers have accessed the vehicle, or after an in-service period of 6 months, whichever is sooner, shall provide a minimum slip resistance. The material will be deemed a failure if the mean PTV is found to be less than 40.0.
- Thereafter, all flooring material types shall be assessed annually for a period of 7 years from the point of entering service. Throughout this period the material shall provide a minimum slip resistance. The material will be deemed a failure if the mean PTV is found to be less than 40.0.

Floors shall be tested according to the protocol defined in Attachment 32 and achieve a ‘Pass’.

Compliance with these requirements shall be demonstrated by providing LBSL with documentary evidence of the performance of flooring material types in the form of United Kingdom Accreditation Service (UKAS) certificates.

New materials shall meet the initial and 6 months requirements as above. In addition, evidence shall be submitted that sets out:

- a) suitable evidence of accelerated wear testing that simulates the extended 7-year use, and
- b) a plan to monitor in service collaboratively with an operator for the 7-year period in order to provide evidence as a verification of the actual wear over that 7-year period.



4.5.7 Door Safety

Front, entrance to be inward glider type, flush fitting to the body side when closed and one-piece full depth glass in each door leaf for maximum driver view of kerb side.

Centre or rear, entrance or exit doors to be outward slider type, flush fitting to the body side when closed and one-piece full depth glass in each door leaf for maximum view of kerb side.

All door header panels must provide adequate prevention against finger ingress to the door operation mechanism.

Door or door partition handrails positioned to assist boarding and alighting must be fitted at all entrance and exit points and must be shown on the approved arrangement drawings as submitted for TfL review and upload to the TfL BVS Database.

Overhead illumination, of door opening area must be provided at minimum levels as stated in section 8.2.

Door closing audible warning device on all exit doors, to be of beeping sound and not to exceed 75 dBA, when measured at 1m height from the body floor on centre line of the bus and exit door. It should be noted that:

- White sound noise type will also be considered
- Voice or other tones are not acceptable
- Warning on exit door opening is not permitted.

The door control logic shall be such that it is not possible for the driver to open the exit door while the access ramp is either in the process of extending or retracting. It shall only be possible for the exit door to be opened when the ramp is either fully retracted or fully deployed. However, it must still be possible for an emergency door operation to over-ride the restriction.

4.6 Partner Protection

TfL are currently conducting further research and assessment of data taken from service conditions to develop the requirements, assessment protocols and guidance notes for Partner Protection and ensure their suitability. As such this section provides an understanding of the current expectations, it is however subject to change.

Bus front ends have been identified as one of the key contact points of the vehicle in collisions with vulnerable road users (VRU). Several different safety features are required to minimise the injury potential in those collisions.

In all assessments of these features, the physical or virtual test vehicle to be assessed shall be configured at its maximum ride attitude from the ground plane, with its mass in running order (the nominal unladen vehicle and driver mass), tyres inflated to manufacturer recommended pressures and vehicle suspension set to normal running conditions (as specified by the OEM for a speed of 25 mph).



4.6.1 VRU Frontal Crashworthiness: Minimum Geometry

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

All bus front ends are required to have a geometric design that both improves protection for VRUs during the primary impact of a collision and reduces the risks of VRUs being subsequently run over.

All buses shall have a front-end geometry that complies with the minimum bus front end geometry requirements for both vertical rake angle and horizontal curvature.

Vertical rake angle is specified as an angle in the longitudinal plane formed at the intersection of the vertical transverse plane of the vehicle and a plane located at a tangent to the test point surface. The minimum requirements shall be:

- Minimum vertical rake angle of $[1]^\circ \pm 0.5^\circ$ tested at the worst-case location between vertical heights of $[0.75]$ m and $[1.2]$ m from the ground plane and the side reference lines; and
- Minimum vertical rake angle of $[4]^\circ \pm 0.5^\circ$ tested at the worst-case location between vertical heights of $[1.2]$ m and 2.0 m from the ground plane and the side reference lines.

To ensure only the global geometric features of the bus front end design are tested, the vertical rake angle shall be assessed using a 236 ± 5 mm x 236 ± 5 mm rectangular plane, with its centre placed against the surface of the bus at the test location.

Where multiple vertical rake angles may be selected at a single test location (e.g. due to the protrusions caused by headlight clusters or bodywork panel joins), then the worst-case vertical rake angle shall be selected.

Wraparound windscreen and bumper bus front end designs, where the glazed areas and bumper at the front-end edges are curved and the A-pillars are located rearward of the bus front end, are required. The minimum requirements shall be:

- A radius of curvature of at least 150 mm tested in the horizontal plane and at the worst-case location between lateral positions of 0 m and 150 mm inboard from each side reference line and between vertical heights between $[0.75]$ m and 2.0 m from the ground plane.

The side reference line is defined by the geometric trace of the most outboard points of contact between a straight edge 700 mm long and the sides of the vehicle, when the straight edge, held parallel to the transverse horizontal plane of the vehicle and inclined rearwards by 75° , is traversed rearwards to contact the sides of the bus front end (Figure 4_6 and 4_7).

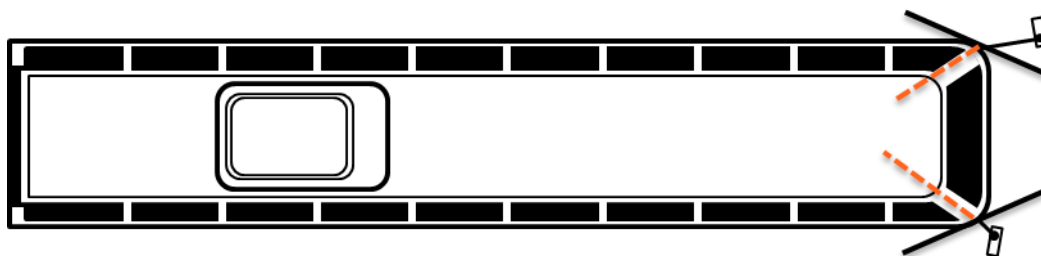


Figure 4_6: Side reference line – plan view

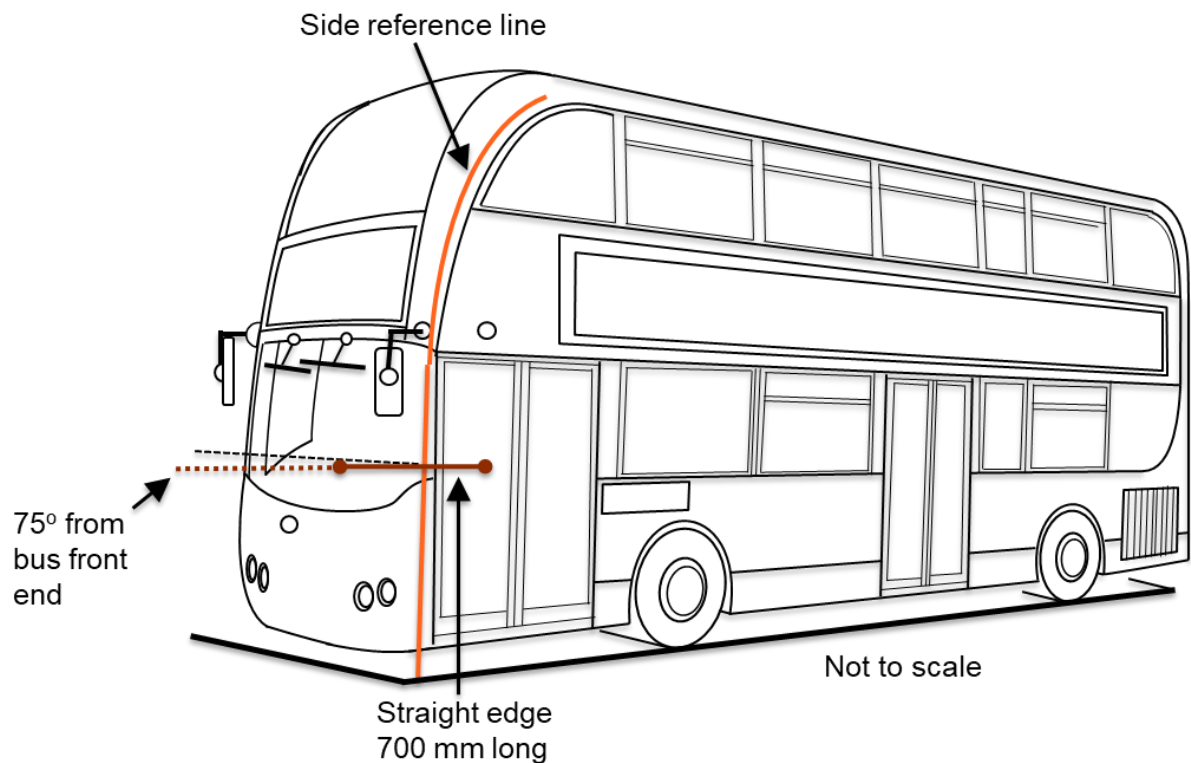


Figure 4_7: Side reference line – front/side view

Compliance may be established through either a CAD based approach or physical testing. The bus OEM shall provide documentary evidence of compliance with these requirements.

4.6.2 VRU Frontal Crashworthiness: Enhanced Geometry

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

All buses shall be assessed in accordance with the bus front end geometry test and assessment protocols (Attachment 39), reporting vertical rake and horizontal angles for each test point, bus front end geometry envelope compliance status, the front end geometry score (FEGS), the bus front end geometry star rating and the number of safety performance criteria scores with a value of 0 for each bus model or bus model variant (as appropriate).

All buses shall have a front-end geometry compliant with the bus front end geometry envelope, which is defined by the following boundary conditions:

- Vertical rake angles for all measuring points at all test positions (P1-P5) shall be no less than 4 ° and no greater than 23 °.
- Horizontal angles for all measuring points at the outboard test positions (P1 and P5) shall be no less than 20 ° and no greater than 33 °.



- Horizontal angles for all measuring points at the inboard test positions (P2 and P4) shall be no less than 11 ° and no greater than 18 °.

Where multiple vertical rake angles may be selected at a single test location (e.g. due to the protrusions caused by headlight clusters or bodywork panel joins), then the worst-case vertical rake angle shall be selected.

All buses shall have a front-end geometry score (FEGS) that exceeds 0 %.

All buses shall have no more than eight safety performance criteria scores with a value of 0.

All definitions for above requirements are provided in the bus front end geometry test and assessment protocols (Attachment 39).

The bus OEM shall provide documentary evidence of compliance with these requirements. This evidence may be supported by the submission of the Front-End Geometry Performance Evaluation Tool provided.

Bus models or bus model variants may be exempt from these requirements, should documentary evidence be provided that demonstrates to the Test Service how the geometric design of the bus front end reduces the risks of VRU injuries and run-overs relative to current designs. A simulation-based test and assessment approach may be provided as evidence. Although the OEM has the responsibility to ensure such evidence provides sufficient assurance of real-world improvements in VRU injury and run-over risks, guidelines on a simulation-based testing approach are provided in Annex 1 of Attachment 39.

4.6.3 VRU Frontal Crashworthiness: Energy Absorption

This requirement only applies to new vehicles entering the fleet from 2024 as per the Bus Safety Roadmap for new build buses

All bus front ends, in the region of potential head contacts, are required to have a construction that absorbs energy to improve protection for VRUs during a collision and in the event of a contact at that location on the vehicle.

All buses shall have their VRU impact safety performance tested and assessed in accordance with the bus VRU impact test standard, as defined in Attachment 36.

All buses shall have front ends which are energy absorbing or sufficiently compliant and/or frangible to meet the performance requirements of the bus VRU impact test standard.

No bus shall have a head form impact test result leading to a head injury criterion (HIC15) value in excess of [1,350].

All buses shall meet the minimum bus VRU impact test performance score (BITS) requirement of [25] %.



4.6.4 VRU Frontal Crashworthiness: Wiper Protection

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

Windscreen wipers, and in particular the windscreen wiper bosses and spindles, that are mounted in the region of a potential VRU impact provide rigid structures that may cause greater injuries if struck. Windscreen wipers are therefore required to be positioned above the windscreen or have a construction that absorbs energy to improve protection for VRUs during an impact.

All buses shall have the impact safety performance of their windscreen wipers tested and assessed at their worst case location in accordance with the bus VRU impact test standard as defined in attachment 36.

Windscreen wipers mounted at a height of greater than 2.0 m from the ground plane shall be exempt from this requirement.

No existing model bus shall have a wiper spigot:

- Lower than 2.0 m from the ground, and
- Without a protective covering that provides a minimum reduction in head injury criterion (HIC₁₅) value of 50 % during a headform impact test.

No new bus shall have a windscreen wiper spigot:

- Lower than 2.0 m from the ground plane, and
- With a headform impact test result leading to a head injury criterion (HIC₁₅) value in excess of [1,350].

Wipers are exempt from calculations of vehicle length. However any additional protection around low mounted wipers shall be included in the vehicle length.

Any proposed design solution must be agreed with the relevant Approval Authority withing TfL prior to implementation.

4.6.5 VRU Frontal Crashworthiness: Mirror replacement Class II CMS

This requirement only applies to new vehicles entering the fleet from 2021 as per the Bus Safety Roadmap for new build buses

In order to avoid situations where mirrors and mirror arms collide with vulnerable road users, all buses shall be fitted with a class II CMS to replace the main mirror. These devices shall be as specified by section 4.3.4.4.

4.7 Miscellaneous Safety features

All wheel arches shall be fitted with tyre blow out protection liners

Headroom should be sufficient at all positions throughout the bus without the need to provide impact protection or warning notices.

In addition to emergency controls on main entrance and exit doors, exits may be provided via main saloon windows or a suitably positioned exit door. These window



positions or door must be shown on the general arrangement drawing as approved by TfL and uploaded to the TfL BVS Database..

Double-deck buses shall be fitted with a substantial near side front tree guard, located into the structure of the bus, giving additional forward protection to the front seated passengers, exterior dome and near side corner window-pillar.

4.7.1 Rescue Sheet & Emergency Rescue Guide (ERG)

To provide information to emergency services, TfL require a Rescue Sheet and Emergency Rescue Guide (ERG) to be custom generated for each specific make and model of bus design by the Bus Manufacturer. The Rescue Sheet and ERG is combined to form 1 document, based on the ISO 17840-2 and ISO 17840-3. Every bus operating on the TfL network shall carry the model specific combined Rescue Sheet and ERG on board at all times, which is to be presented by the Bus Driver to Fire and Rescue services in the event of an incident.

4.7.1.1 Rescue Sheet

The purpose of the rescue sheet is to use as little text as possible, it is 'quick information' for first responders.

When creating a rescue sheet, the following specification shall be followed:

- The structure of the template must follow ISO 17840-2:2019
- All pictograms used must be taken from ISO 17840-2:2019. Any other pictograms shall be deemed non-compliant.
- Ensure the quality of the picture / drawings / photos / pictograms follow the General Recommendations in ISO 3864-1. This is to make certain that the document is easily read and understood.
- Ensure the quality of the picture / drawings / photos / pictograms is a minimum of 300 DPI, as per ISO 17840-3:2019. Therefore: do not copy and paste pictograms from other documents
- The rescue sheet must be combined with the ERG (see section 4.7.1.2)
- The Rescue Sheet and ERG must be printed double sided, minimum A3, and be able to withstand use during fire service operations. Therefore, it shall be printed on a suitably robust material to protect the sheet from the elements and wear and tear, such that it can last the life of the vehicle.
- Before any Rescue Sheet is put into service it must be verified by TfL.
- A full user guide with examples can be provided by TfL to assist in the creation of a Rescue Sheet.
- A digital copy of the Rescue Sheet shall be provided to TfL.
- A monthly check should include the visual inspection of the Rescue Sheet and ERG, ensuring it is present and not damaged or illegible. Any issues must be reported, in line with operator processes for issue reporting.

An example of a Rescue Sheet combined with an Emergency rescue Guide is [located on the TfL BVS Data Base HERE](#).



4.7.1.2 Emergency Rescue Guide (ERG)

When creating the ERG, the following specification should be followed:

- The structure of the template must follow ISO 17840-3:2019. For guidance a full template for completing an ERG is provided in Annex A of ISO 17840-3:2019.
- All pictograms used must be taken from ISO 17840-3:2019, any other pictograms shall be deemed non-compliant. All pictograms must be used in a consistent way when describing the same matter.
- Ensure the quality of the picture / drawings / photos / pictograms are following the General Recommendations in ISO 3864-1. This is to ensure that the document is readable and easily understood.
- Minimum recommended resolution of images should be 300 DPI. Any distracting information on images should be removed (e.g., faces, people).
- The ERG must be combined with the Rescue Sheet (see section 4.7.1.1)
- Before an ERG is put into service it must be verified by TfL.
- A digital copy of the ERG shall be provided to TfL.
- The ERG must be suitably robust to last the lifespan of the bus
- A monthly check should include the visual inspection of the Rescue Sheet and ERG, ensuring it is present and not damaged or illegible. Any issues must be reported, in line with operator processes for issue reporting.
- The rescue sheet and ERG must be printed double sided, minimum A3, and be able to withstand use during fire service operations. Therefore, it shall be printed on a suitably robust material to protect the sheet from the elements and wear and tear, such that it can last the life of the vehicle.
- The Rescue Sheet and ERG must not exceed 5 pages.
- A full user guide with examples can be provided by TfL to assist in the creation of an ERG.

An example of a Rescue Sheet combined with an Emergency rescue Guide is stored in the [supporting documents location of the BVS Database HERE](#)

4.7.2 Rescue Sheet and ERG Storage

- The rescue sheet and ERG must be stored in a folder within the driver's cab. The location should ensure the folder is not easily damaged and is still easily accessible for the driver/emergency services.
- The folder is to be provided by the OEM and be properly affixed to the cab.
- The folder should be stored within the drivers cab.
- The folder shall be red and follow the design shown in Figure 4_8 below.



Figure 4_8 ERG folder logo, colour and design requirement

- The method of storing the Rescue Sheet and ERG must be suitably robust to last the lifespan of the bus
- In the event of a fire, the driver must remove the folder (if safe to do so) and provide the fire service with the information upon their arrival



5 Environmental Performance

5.1 General

The combined engine and transmission acceleration controls should limit the bus to a rate that delivers an acceptable LBSL emissions performance whilst still providing the driver with adequate acceleration performance in the fully laden condition.

Full bodywork insulation shall be fitted to sides, roof, front and rear and internal bulkheads where appropriate to minimise heat loss from the heated passenger saloon to the environment in cold weather and to minimise heat intrusion from the engine into the passenger saloon, particularly in warmer conditions.

5.2 Air quality and emissions

The tailpipe emissions from the bus shall be measured according to the process defined in Attachment 1 and shall fall within the limit values specified in that Attachment.

Bus production lead times to certification shall be minimised at times of Euro legislation updates, providing the earliest introduction of latest emissions legislation. No advanced registration of earlier Euro status engines will be accepted.

The use of BS EN 590:2000 (50 ppm sulphur) compliant diesel fuel is a minimum requirement. Fuel utilised may also be subject to verification by a LBSL testing procedure.

Any alternative fuels, additives, after treatments, power sources or technology that may potentially change the agreed emissions standards will require the prior consent of LBSL before their use in LBSL's contracted bus fleet. OEM / Supplier funded testing over the LBC cycle under LBSL supervision is required to establish that the technology proposed delivers emissions standards that are better than the equivalent currently used standard bus.

Exhaust fumes should be delivered on or below the bus skirt to the rear of the bus, either at the offside portion of the rear of the bus, or on the offside of the bus, behind the rear axle. Exhaust fumes shall not be emitted at the near side of the bus. If any exhaust fumes are not delivered on or below bus skirt level, they should be delivered at roof level with the final position agreed with LBSL prior to bus manufacture / design.



To prevent buses running engines or over using high voltage systems (in the case of Zero Emission Vehicles) and ancillary systems for long periods whilst stationary, an automatic ignition shutdown system shall be incorporated.

The engine or high voltage systems (in the case of Zero Emission Vehicles) and any noise generating ancillary systems shall be automatically shut down when the following 2 conditions are met:

- The bus has been stationary for 2.5 minutes

AND

- The park brake is applied.

The driver shall be provided with:

- An audible warning 1 minute prior to the shut down

AND

- Have the facility to override this back to the 2.5 minutes of stationary operation

All buses shall have this idle shutdown operation, regardless of powertrain type.

5.3 Carbon Dioxide Emissions

The bus OEM shall, for buse types, provide a statement of the embedded carbon footprint of the bus covering initial manufacturing to disposal at the end of a 14 year life cycle. This calculation shall exclude consumables used during operations.

Hydraulically driven cooling fans, for any system, shall not be permitted.

5.4 Noise emissions

The braking system should use disc brakes at each wheel station in order to minimise brake squeal.

The exterior and interior noise level of the bus shall be tested and assessed using the method defined in Attachment 2. The complete vehicle supplied for testing either by the OEM or an operator shall be fully compliant with all other aspects of this specification and be fitted with all equipment necessary for operation in London.

The results of the test shall demonstrate that the drive-by noise test emissions are at least 1 dB less than the legal limit (diesel buses) or 2 dB less than the legal limit (hybrid buses) defined in type approval regulation. Zero Emission Buses shall be at least 3 dB less than the legal limit

All noise test results may be subject to LBSL verification at any time.

The OEM shall demonstrate compliance with this requirement by providing a copy of both the type approval certificates relating to the noise tests and a LBSL type approved noise statement, as set out in Attachment 2.

5.5 Infrastructure protection

Buses shall be equipped with road friendly suspension, which is defined as a suspension system where at least 75 % of the spring effect is caused by an air



spring or where the suspension is recognised as equivalent to air suspension using the definitions of Annex II of Council Directive 96/53/EC on authorised weights and dimensions.



6 Operational Efficiency

Buses shall be capable of high frequency, stop-start, fully passenger laden Public Service Vehicle (PSV) operational schedules, operating in adverse traffic conditions, during typical London weather conditions. The typical operational parameters are 18 hours per day, 7 days per week, 364 days per year, with an average operational speed of between 6 and 12 mile/h, and a minimum average daily range of 150 miles without the need to refuel the bus.

The bus proposed must be suitable to achieve a minimum efficient operational life within London of 14 years.

6.1 Vehicle capacity

OEMs must have general dimensions, seating and layout arrangement drawings agreed by LBSL as approved by TfL and uploaded to the TfL BVS Database. These individual manufacturers' drawings should comply with the detail below. They are deemed to be approved by LBSL if marked with a valid a LBSL reference number issued from the Nominated Officer. The respective OEM's LBSL reference number must be quoted on all proposals. If a OEM cannot provide the approved LBSL reference number, a fully dimensioned general arrangement drawing for the proposed bus must be provided by operators submitting a bid based on the use of that vehicle. LBSL reserves the right to not consider bids unless this condition can be satisfied.

Any amendments to any of these layout drawings will require the approval of LBSL before a bus constructed with the revised layout can be used in service in London.

A laden and kerb / un-laden weight chart by axle and total against GVW shall be provided for the completed bus Body Layout Option. This must be approved by LBSL. Any significant changes to this standard must be notified to LBSL.

Unladen weight has a relationship to fuel economy and buses should be designed to maximise their fuel economy.

The standing capacity of the bus will be determined by the lower of the calculation be weight (using 68 kg per person) and no more than 6 standees per square meter in the areas of the bus where standing is permitted.

All buses should comply with the general dimensions and capacities defined in Table 6-1 and a layout drawing identifying the actual dimensions and capacities for the bus shall be provided to LBSL. Any configurations that do not fit the table should be discussed with TfL.

The wing mirrors are not included in either the width or length of the bus.



Table 6-1: General Dimensions and Capacities

Passenger capacity (minimum)		Single deck Single door 36		Single deck Single door 45		Single deck Dual door 50		Single deck Dual door 55		Single deck Dual door 60		Single deck Dual door 70		Double deck Dual door 87	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Overall Length*	metres	7.8	7.9*	8.9	9.0*	9.3	9.9*	10.1	10.4*	10.4	10.9*	11.5	12.0*	10.1	10.9*
Overall Width*	metres	2.30	2.55*	2.45	2.55*	2.45	2.55*	2.45	2.55*	2.45	2.55*	2.45	2.55*	2.45	2.55*
Overall Height (non- Zero Emission)*	metres	2.85	3.10*	2.85	3.10*	2.85	3.10*	2.85	3.10*	2.85	3.10*	2.85	3.10*	4.20	4.42*
Overall Height (Zero Emission only)*	metres	2.85	3.40*	2.85	3.40*	2.85	3.40*	2.85	3.40*	2.85	3.40*	2.85	3.40*	4.20	4.42*
Aisle headroom at centre line	metres	1.83		1.83		1.83		1.83		1.83		1.83		1.83	
Seat Width	mm	440		440		440		440		440		440		440	
Aisle Width (between seats) - top of seat back	mm	590		590		590		590		590		590		590	
Aisle Width (between seats) - bottom of seat back	mm	535		535		535		535		535		535		535	
Objective Wheelchair space **	metres	2.0		2.0		2.0		2.0		2.0		2.0		2.0	
Entrance & Exit step Height (Un-knelt)	mm		320		320		320		320		320		320		320
Entrance & Exit step Height (knelt)	mm	265	240	265	240	265	240	265	240	265	240	265	240	265	240
Entrance & Exit Door Headroom	mm	1840		1840		1840		1840		1840		1840			
Entrance Door Clear Width***	mm	1200		1200		1200		1200		1200		1200		1200	
Exit door Clear Width***	mm	n/a		n/a		1200		1200		1200		1200		1200	
Passenger capacity:-															
Total		36		45		50		55		60		70		87	
Low Floor Seated: Priority		4		4		4		4		4		4		4	
Low Floor Seated: Preferential (in addition to Priority)		2	4	2	4	2	4	2	4	2	4	4		4	
Total Seated Lower Deck		18		24		24		26		30		35		21	
Total Seated Upper Deck		n/a		n/a		n/a		n/a		n/a		n/a		41	
Total Standing (assuming <6 people/sqm of standee floor space)		15		20		24		26		28		32		22	
Wheelchair		1		1		1		1		1		1		1	
Standing with wheelchair		11		18		20		22		24		28		18	

*= Subject to being able to traverse the specified route and serve all stops safely

**= target - subject to a agreement on total capacity and seating a minor reduction may be permitted

***= Refer to Section 6.3 for further details



6.2 Energy efficiency – Electric Vehicles

OEMs and Operators need to be satisfied that the battery capacity, charging regime and battery life of vehicles are suitable and appropriate for the route(s) on which they are proposed, including the heating and cooling requirements set out in this specification.

6.2.1 Minimum Charging Requirements

Each bus must be capable of DC charging via a CCS combo-2 socket. Other type connections can be installed as an option.

6.2.2 Opportunity Charging

Where a bus is fitted with an Opportunity Charging system, it shall comply with the design and operation requirements detailed in the [OPPCharge Specification – 2nd Edition 20190421](#)

The latest version of which is available for download from oppcharge.org

6.2.2.1 Performance Tracking

The following parameters shall also be logged and made available to TfL in order to monitor vehicle and system performance in use (required units in brackets):

- Vehicle Energy Consumption (kWh/km)
- Charge time (minutes)
- Charge Energy Transfer (kWh)
- Charge Power Transfer (kW)
- Charge Efficiency (%)
- Vehicle Total Battery State of Charge – Pre-Charge (%)
- Vehicle Total Battery State of Charge – Post-Charge (%)

6.3 Minimising dwell time

The choice of the number of doors fitted to a bus shall be informed by an analysis of the effect of dwell time at typical bus stops on the route intended for.

London Buses generally operate a two door system with the entrance door forward of the front axle and the exit door between front and rear axle. When single or three door buses are requested, the front door remains unchanged, the centre door is deleted or duplicated at a specified area of the bus.

Requirement for all service doorways are as follows:

Entrance and exit doors shall provide a minimum individual clear width of 1200 mm, utilising an equal width two door leaf closure. A reduction in the clear width is permitted as defined within UNECE Regulation 107 as amended. Where a reduction is required, the minimum individual clear width of 1030 mm must be maintained across the entire height of the door.



6.4 Fleet management

6.4.1 CCTV/Audio recording

Colour Digital CCTV shall be fitted to all buses and shall provide the specific functionality defined in Attachment 11.

Evidence shall be supplied to demonstrate that

- recording systems fully comply, at all times, with the relevant principles of the General Data Protection Regulations (GDPR)
- operators have registered for this type of application with the Information Commissioner's Office
- Privacy Impact Assessment (PIA) has been completed and signed
- PIAs will be reviewed periodically to ensure measures continue to remain proportionate and/or necessary.
- A full detailed privacy notice has been placed on your company website, with the website information included in the space on the sign.

Recording equipment will be subject to periodic auditing for installation compliance and serviceability.

Where audio recording (which is optional) is installed, these requirements apply to both continuous and driver activated recording devices, (eg Incident Data Recorders). Close proximity (directional) microphones must be used to ensure only conversations in the immediate area around the driver cab can be heard. Signage informing passengers that audio recording is operating in the driver's cab area shall be installed. This will be issued by LBSL.

6.4.2 Fleet Management System

All buses shall be fitted with Fleet Management System version 3, unless specifically exempt as agreed with LBSL.

The Fleet Management System should be compliant with the requirements set out in Attachment 3.

All buses shall be provided with ducting and cable runs to ease the installation of additional equipment. These shall meet the requirements defined in Attachment 4.

6.4.3 Communications

LBSL will issue, free of charge, iBus equipment to operator or OEM against each set of new vehicles confirmed by LBSL

All buses must make provision for the installation and suitable protection of this equipment. The approved package of installation must consider the free issue iBus equipment as an integral part of the design of the vehicle.

For full details of the installation principles recommended, refer to the generic 'iBus Installation Manual' [Document Ref: LBSL Equipment for new buses Installation



manual BHN01 170970V15] which has been issued to all bus OEMs. A copy of the 'iBus Installation Manual' is available on the Hyperion server to all bus operators.

For any new bus types or modifications to the roof area of existing designs, the position of the antenna must be approved by LBSL Drawings showing the roof layout and positions/ dimensions of all roof mounted equipment must be submitted as part of the general arrangement drawing.

The bus communications antenna should always be positioned on the highest point of the roof and spaced well away from any other objects or obstructions.

In order to maintain the omnidirectional radiation pattern of the antenna and to avoid the shielding of radio signals in certain directions, a minimum spacing between the antenna and any other object that protrudes above its mounting point must be observed:

- Objects up to 300 mm in height above the antenna mounting point must be spaced at least 1000 mm away from the antenna.
- For objects that are between 300 mm and 500 mm in height, the minimum spacing must be increased to 2000 mm.
- If the item height exceeds 500 mm, please contact LBSL's Radio Infrastructure Engineer.

No electronic equipment may be located in the roof space directly underneath or within 500 mm of any part of the bus antenna. Any cables routed within this zone must be fully screened and bonded to the vehicle earth at both ends.

6.4.4 Ticketing

LBSL will issue, free of charge, a ticketing machine, base plate and smart card readers to operator or OEM against each tender award. A coin tray is not required.

All buses shall make provision for the installation and suitable protection of this equipment. The approved package of installation shall consider this ticketing equipment as an integral part of the design of the vehicle.

For full details, refer to the installation and provision of electrical supply to the Ticket Machine as described in the document "Guidelines for Bus Builders for the installation of Ticket Machines with Smart Card Readers", published by the ticketing system supplier and available from LBSL.

Note: The ticket machine and equipment will be installed after a bus arrives in London.

By preference, the card validator should be separated from the main Electronic Ticket Machine (ETM) and located outside the driver's cab to permit a straight forward cab seal and allow best ergonomic access for passengers to present their card.

The passengers should face the driver when validating.

Passengers shall be able to easily see the ETM screen (for error messages, current balance, etc).



The Smart Card Reader shall not be located rearward of an angle of [70 degrees] from the centreline of the bus from the driver's seating reference point.

Access shall be provided to allow the Smart Card Reader and ETM to be removed with minimal effort.

By preference, the main body of the ETM should not protrude through the assault screen. The Smart Card Reader may protrude if sealed effectively. See Figure 6_1Figure for best practice example.



Figure 6_1: Smart Card Reader ONLY protrudes through the assault screen

Note: this material must also comply with assault screen materials requirements regarding vision and impermeability to air.

In some cases, the assault screen might seal over the ETM and the Smart Card Reader, separating the Passenger from Smart Card Reader. In these cases, the Smart Card Reader should be ergonomically accessible and the distance between the Smart Card Reader and the seal material shall be no more than 10 mm at the furthest point to provide a consistent accuracy of card reading. See Figure 6_2 for a best practice example.



Figure 6_2: Flexible plastic over the top of Smart Card Reader pad. Held in place by a removable polycarbonate panel

Access to paper printed tickets (including paper roll change) is not required.

The ticket machine base position shall be provided with a clean power supply that is maintained for 30 minutes after shutdown.



7 Accessibility

The completed bus must be designed as a low floor.

A minimum of 4 priority seats shall be provided and must be clearly identified by the standard (LBSL Issue) notice.

A minimum of a further 2 additional “preferential” passenger seats shall be provided in the low floor area (see table 6-1), for passengers who are less able to stand or who are travelling with small children. These will be of similar space requirement to the priority seats. Preferential seats must be clearly identified by the standard (LBSL Issue) notice.

Priority or preferential seating on the low floor area shall maximise under-seat space as much as possible, for use by guide or assistance dogs. The height from the floor to the top of the seat cushion should be approximately 490 mm to achieve this

All of these seats will be fully defined on the approved seating layout as approved by TfL and uploaded to the TfL BVS Database.

All buses must make provision to carry a wheelchair and its occupant. Buses shall be designed such that wheelchair access is via the door positioned mid wheelbase on two or more door buses or via the front door on single door buses.

An access ramp shall be provided to enable wheelchairs to ride across the gap between kerb and vehicle. Access ramps shall:

- Be power operated by driver controls;
- Telescopic single or two stage ramp platform type with minimal deviations in surface plane;
- Have a total platform length of no less than 1000 mm when fully deployed. This length must not include any section of the floor;
- Not incorporate a hinged lowering floor section or any similar design arrangement intersecting with the top of the ramp platform;
- Incorporate exterior ramp request buttons adjacent to the wheelchair entrance / exit door. These must be positioned clear of the open door position;
- Be installed in a way that maximises protection of the ramp from damage and operational reliability;
- Incorporate an audible warning of ramp deployment. The warning shall be of beeping sound and shall not exceed 75 dB(A), when measured at 1.25 m height from the exterior ground, on the centre line of the exit door at a distance of 1.5 m.
- Automatically undertake a partial operation extending cycle of approximately 50 mm deployment on every start-up of the bus. This is to test the ramp and remove any loose dirt or debris from ramp mechanisms. The ramp deployment audible warning device must not sound during this test operation.
- Display a constant warning light in the driver’s cab if operation of the ramp fails in service. This shall remain illuminated whenever the bus is in use, until a successful ramp operation occurs.



- Be positioned such that the ramp forward edge is recessed at the centre door from the main bodywork exterior by not less than 25 mm and ideally by 35 mm. The area between the lower edge of the closed door leaf and the floor should be protected against water or any other form of material ingress.
- Function on all kerb surfaces likely to be encountered on London streets.

Objective wheelchair area length shall be ≥ 2000 mm unless agreed otherwise by the Nominated Officer. The wheelchair area shall be located on the off side:

- Opposite the wheelchair entrance / exit door (two or more door buses.)
- Immediately rearward of the driver's cab and wheel box (where appropriate) (Single door buses).

The wheelchair interior manoeuvring area and the ramp deployment area must be monitored by CCTV and displayed on the driver's cab monitor when doors are open.

The wheelchair area shall provide alternative buggy space and standing area when not in use by a wheelchair user. Suitable hand rails and leaning rails must be provided for this purpose.

A wheelchair logo shall be incorporated into the floor covering, readable by a person facing the off side of the vehicle. The logo shall display the rearward facing position of the wheelchair. The full wheelchair area shall be coloured blue (as close as possible to the blue used on the wheelchair notice, PMS 300) and the wheelchair logo shall be coloured white. The wheelchair logo must comply in size and appearance to that shown in Attachment 7. The designated wheelchair area must be shown on the respective OEM's bus layout drawings as approved by TfL and uploaded to the TfL BVS Database.

The main floor covering surrounding the wheelchair area may be coloured at the discretion of the operator but must offer substantial colour contrast compared with the full wheelchair area.

The wheelchair floor to ceiling security handrail must have two bell pushes. The lower (blue button, facing forwards) to activate ramp request (as required by PSVAR2000) and a higher (red button, facing rearwards) as a standard bell push.

The wheelchair stanchion hand pole should not attach to the floor to allow for unhindered manoeuvres into and out of the wheelchair area.

The ramp request blue button push operation must activate an alternative sound from that of the standard bell push. The alternative sound must be:

- audible each time the button is pressed
- clearly audible from the wheelchair position
- easily accessible by the wheelchair occupant while in the recommended travelling position.

The blue ramp request button when pressed must:

- illuminate a ramp request light in the driver's cab
- be clearly visible
- remain illuminated until the wheelchair exit door is opened



A manual or automatic security arm shall not be used to replace the floor to ceiling handrail.

Note: Special attention to the design and positioning of the vertical stanchion pole around the wheelchair area is required to ensure the wheelchair manoeuvrability space is optimised for access and egress. A fixed anti-slew wheelchair restraint design arrangement to the aisle side of the wheelchair area that avoids the stanchion being fixed to the floor would be a preferred option. In addition, special attention must also be given to ensuring the blue access ramp request button is easily reached by the wheelchair occupant travelling in the recommended rear facing position.

Stanchion pole design/arrangements must be such that standing passengers are not able to support themselves in the seating position.

All bell pushes are required to be marked in brail with the brail symbol for the letter S, as shown in Figure 7_1, and the word 'STOP' in white. This is to provide additional assistance to the iBus audible information announcements.

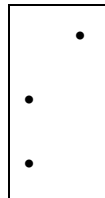


Figure 7_1: Brail symbol for S

Bell pushes at priority seating areas must be positioned such that they are within easy reach, and passengers can remain seated while operating them.

Buses shall be fitted with an induction loop system linked to iBus announcements, and for driver-passenger communication with T band electronic hearing device(s). The following areas must be covered by induction loop(s):

- Passenger entrance platform / cab interface
- Priority seating positions
- Wheelchair area

The induction loop zones must provide sufficient audio frequency levels to ensure passengers using T band electronic devices can comfortably hear the driver and iBus announcements when positioned in each of the above areas.

Each bus type will have unique differences depending on seating layout, single/double deck, loop pad size, panel design, and available space behind panelling. The induction loop installation standards should take all of the design features into account to ensure the system functions are at the optimised operating range, providing the best possible service to customers.

A driver's cab microphone, for communicating with passengers using T band equipment must be:

- Active at all times when the bus is in service.
- Positioned to the side or above the driver partition screen.



Nationally accepted signage/notices shall be attached at each location identifying induction loop zones.

The induction loop supplier and OEM must provide to LBSL a specification document for each bus type showing:-

- Exact pad location using visible datum points and measurements for loop positioning
- Audio frequency field strength using diagrams showing coverage along swept area, horizontal and vertical axis
- Background noise, interference does not exceed the recommended limits as defined in standards BS7594, BS6083, BS6840, BS EN 60118

To ensure consistency in testing methods and standards; the height measurements within the swept area must be specified to ensure all passenger groups including seated, wheelchair users and standing passengers have a clean audio signal free from interference.

Only testing and measuring equipment approved by the induction loop supplier must be used.



8 Occupant Experience

8.1 Driver cab ergonomics

The general layout shall be suitable as a working environment and be ergonomically designed to assist and protect the driver.

The windscreen in front of the driver shall have a tinted section at the top or a suitable sunblind

A driver operated PA system (for driver to passenger communications) will be provided as part of the iBus system.

The cab area must be designed to accommodate the iBus system as described in section 4.3.2, 4.9 and 4.10 of the generic iBus installation manual (BHN01 1709 70V15) with details of the optimal and acceptable zones recommended for placement in the cab of the driver's iBus MDT terminal, microphone and speakers.

The cab area must be designed to accommodate the ticketing equipment as described in electrical section and in the specification document "Guidelines for Bus Builders for the installation of Ticket Machines with Smart Card Readers", published by the ticketing system supplier and available from LBSL

8.2 Passenger saloon ergonomics

All side glass windows (excluding doors and driver's signal window) of identical tinted glass, where legally permitted.

- Solar energy transmittance of not more than 65 %
- Light transmittance of not more than 80 %

As part of the iBus system, illuminated display signs providing passengers with information on the next stop will be provided (on both decks where applicable). These shall be suitably positioned for maximum visibility to passengers. Suitable mouldings and fixings for the LBSL provided iBus signs must be provided. Duplication of this iBus signage is not permitted with LBSL's consent.

Interior saloon lighting shall provide the minimum levels of illumination at the locations defined below:

- Seats, 150 mm above cushion level: 150 Lux
- Aisles, at floor level on bus centreline adjacent to each and every seat: 100 lux
- Steps, at floor level at the centre of entrance and exit steps: 100 lux
- Double deck stairs, at floor level on the centre of every tread: 100 lux

The interior saloon lighting shall be automatically switched off when exterior ambient illumination levels are sufficiently high.

Turning on of the interior lighting shall remain under the driver's control.



8.3 Heating, Ventilation & Air Conditioning (HVAC)

8.3.1 Drivers Cab

8.3.1.1 Drivers Cab HVAC

- The HVAC system for the bus shall keep the driver's cab air supply and recirculation system completely separate to the passenger saloon system.
- The bus shall be capable of feeding the driver's cab with 100% fresh air, and shall provide an automatic, demand controlled ventilation system that automatically keeps CO₂ levels in the cab below 800 ppm at all times.
- The CO₂ sensor shall be placed under the dashboard, away from vent.
- CO₂ levels shall stay below 800 ppm, the HVAC system shall switch to a mode in which the air intake is split between fresh air and recirculated air. Evidence of this shall be provided as part of the Assessment Protocol detailed in Attachment 9.
- Continuous operation shall be ensured up to 45°C. Above 35°C, the system may operate with a permissible derating, but shall reduce temperatures by ≥10 °C in the driver's cab.
- The driver shall be able to control:
 - Heating and cooling output (between -3°C and 35°C ambient temperatures).
 - Vent direction.
 - Fan speed (where driver demand is above the minimum required fresh air demand to meet the required 800 ppm CO₂ level).
- All air vents in the driver's cab shall deliver treated fresh air to meet the driver's demand. The driver shall always have full control over whether or not the fresh air is heated or cooled. All air vents shall deliver a homogenous mix of air.
- There shall be a minimum of two vents blowing directly towards driver's face and additional two vents towards the feet:
 - The driver shall be able to control the direction of air flow from these adjustable vents.
 - The driver shall not be able to shut air flow off at any vents.

8.3.1.2 Windscreen Demist

A windscreen demisting system shall be provided and shall be fully controlled by the driver. The windscreen shall demist effectively and equally on both sides of the driver assault screen partition and meet the performance requirements detailed in Attachment 9; Section 9.1.

- Where an air supplied system is fitted, it shall:
 - Operate independently from the saloon heating, upper deck cooling or cab air conditioning.



- Be fed by exterior fresh air, or with recirculated air within the driver's cab if CO₂ levels are below 800ppm; there shall be no mixing or recirculation with passenger saloon air.

8.3.2 **Passenger Saloon**

8.3.2.1 *Passenger Saloon HVAC*

All buses shall be fitted with a fully automatic saloon HVAC system. These HVAC-systems shall meet the following requirements:

- A blown air HVAC system shall be independently controlled and delivered to both lower and upper deck where applicable. The HVAC system shall be designed for each applicable deck such that:
 - Heating shall be supplied at floor level (at a maximum vertical height of 30 cm above floor level).
 - Cooling shall be supplied from ceiling level (at a maximum vertical height of 30 cm below the ceiling, where the ceiling is defined as the highest point of the interior of each applicable deck).
- All direct contactable vent surfaces and air flow temperatures shall not exceed 45°C.
- A maximum air velocity of 5m/s is permissible at shoulder height for a passenger, 1.1m for seated passengers and 1.6m from the floor for a standing passenger.
- The supply of floor heating within the designated wheelchair area shall ensure that:
 - Any ducting/vent designs are free from obstructing wheelchair access, manoeuvrability and/or prevent the correct safe travel positioning of the wheelchair/scooter.
 - The wheelchair bay still meets the requirements detailed in section 7 and table 6_1 of this document.

8.3.2.2 Passenger Saloon HVAC Thermal Performance

- A minimum of 2 temperature sensors shall be used, placed in each of the three zones highlighted in Figure 8_1 below for effective measurement of temperatures and minimal disturbance. The first temperature sensor shall be placed between floor level to 0.3m, and the second sensor shall be placed between 0.9 m to 1.2 m from the floor. The sensors to be positioned such that no direct blown air or convection heat is directed at the sensors. The HVAC system shall not continuously change from heating to cooling and vice-versa to maintain these setpoint saloon temperatures. The ambient temperature sensor should be positioned so that it is not directly influenced by wind effect or solar radiation.

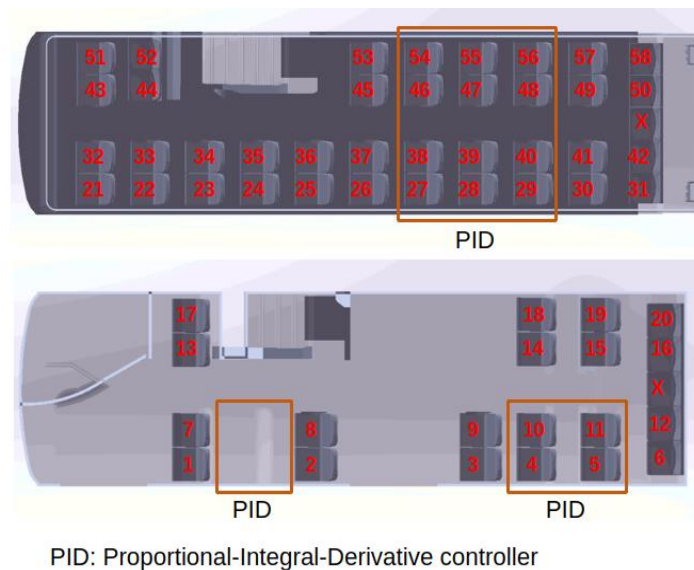


Figure 8_1 Approximate locations for temperature sensors on lower and upper decks where relevant to vehicle type

- A combined 3-minute rolling average temperature shall be calculated per deck and used for the automatic thermostatic control, to derive saloon temperatures as per Table 8_1, using all temperature sensors.

Ambient Temperature, T_A (°C)	Saloon Temperature, T_s (°C)
-3	13
5	13
12	16
17	17
25	22
30	26
35	26

To calculate saloon temperature for any given ambient temperature between 5°C and 12°C:
 $T_s = (3/7)T_A + (76/7)$

To calculate saloon temperature for any given ambient temperature between 12°C and 17°C:
 $T_s = (1/5)T_A + (68/5)$

To calculate saloon temperature for any given ambient temperature between 25°C and 30°C:
 $T_s = (4/5)T_A + 2$

Table 8_1 Ambient vs Saloon temperature set point

Within an ambient temperature range of -3°C to 17°C there shall only be heating and between 25°C - 35°C there shall only be cooling. Between 17°C - 25°C no heating or cooling is necessary.

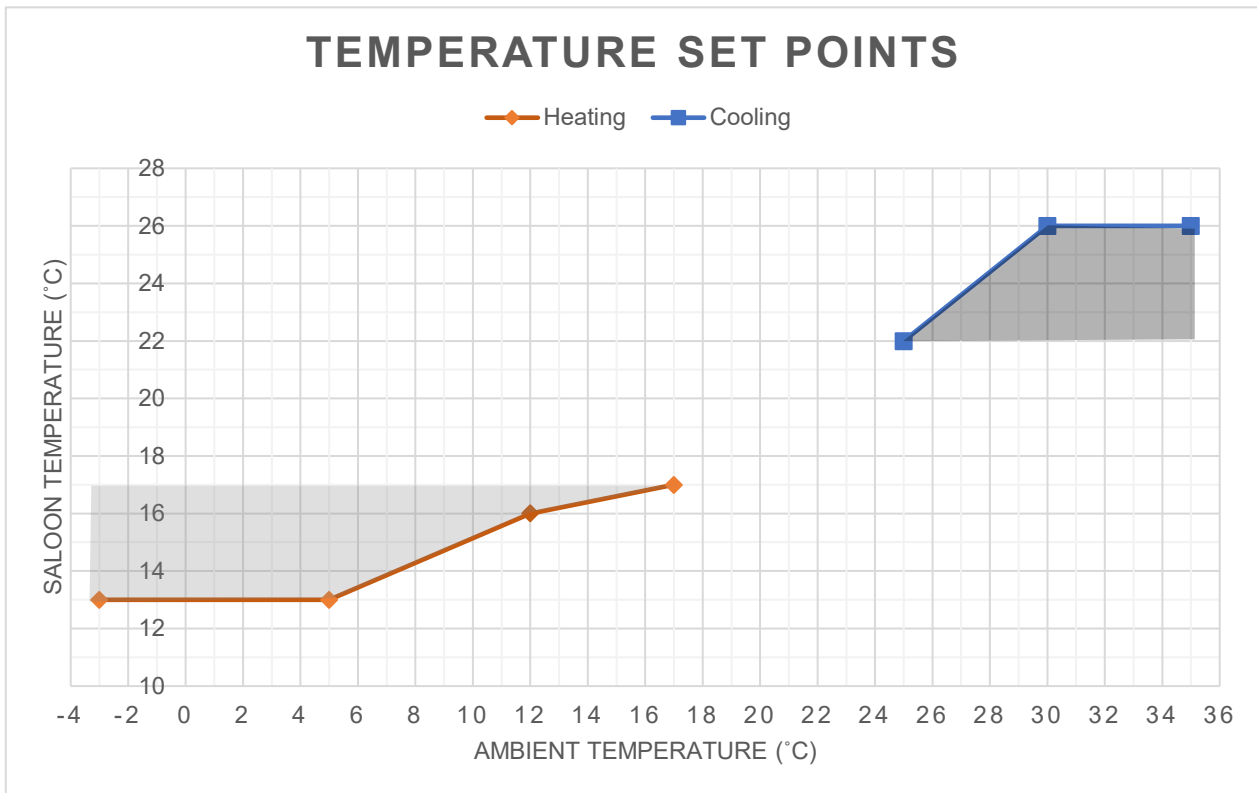


Figure 8_2 Temperature set points for heating and cooling lower limits

- The shaded areas in figure 8_2 represent the recommended upper and lower limits for heating and cooling respectively.
- Temperature differentials shall remain as low as possible with:
 - A maximum allowable deviation of 5°C across the bus, in each deck, in the longitudinal axis
 - A maximum allowable deviation of 3°C in temperatures in the transverse axis, from head level to foot level.

With regards to humidity during cooling modes, the bus shall ensure that:

- a) Humidity does not exceed a maximum of 50% relative humidity when interior temperatures are between 35°C to 40°C
- b) Humidity does not exceed 70% when bus interior temperatures are between 0°C and 24°C
- c) Between 29°C and 25°C the humidity may linearly decrease within limits shown in figure 8_3:

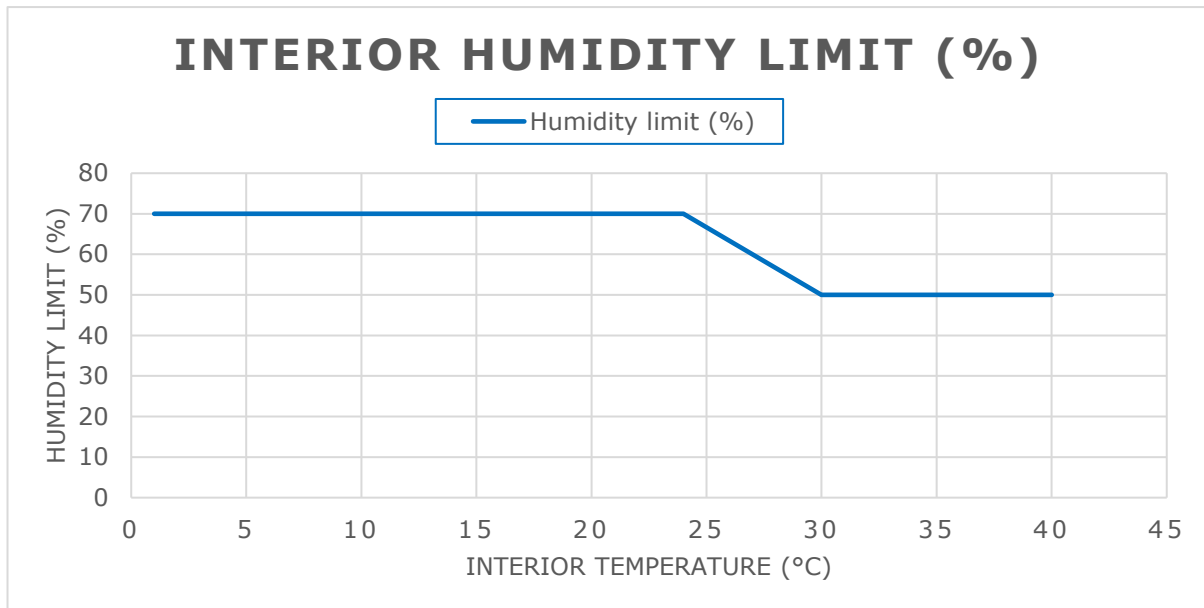


Figure 8_3 Air humidity as a function of the interior temperature

8.3.2.3 Passenger Saloon HVAC Ventilation Performance

All buses shall be equipped with a demand-controlled forced ventilation system designed to automatically keep CO₂ levels below 1200 ppm. Below 1200ppm, the HVAC system may operate in recirculation mode.

Fresh air supply shall automatically increase depending on the CO₂ levels in the passenger saloon up to a maximum of at least 15m³ per hour per person of fresh air for a fully loaded vehicle.

- The ventilation system shall
 - Provide good circulation of air throughout the length of the bus interior and ensure an even temperature and fresh air distribution.
 - Utilise a control system to calculate 3-minute rolling average CO₂ levels per deck for determination of saloon CO₂ levels and ventilation control using all CO₂ sensors.
 - Be independently controlled and delivered to both lower and upper deck where applicable. The HVAC system shall be designed such that fresh air can be supplied to the lower or upper deck depending on CO₂ averages.

CO₂ sensors shall be positioned in each of the three zones highlighted in Figure 8_1 in a tamper proof location.

- On the lower deck, the CO₂ sensors shall be placed on the PID Zone between floor level to 0.3 m.
- Similarly, for the upper deck, the CO₂ sensors shall be placed on the PID Zone between floor level to 0.3 m.



- The external air inlets to the HVAC system for the saloon only shall be greater than 2m from ground level.

8.3.2.4 HVAC Air Filtration

All HVAC systems shall be fitted with air filtration on the recirculation section of the system which meets either;

- a) A minimum efficiency standard of ISO16890 Coarse 65%, minimum anti-viral efficiency of 99.9% against ISO18184 and minimum anti-bacterial efficiency of 99.9% against ISO20743

OR,

- b) A minimum efficiency standard of ISO16890 ePM1 (very fine filtration capable of virus capture) whilst maintaining acceptable change interval frequencies.

OR,

- c) Another method which can be independently verified to provide equal or superior performance to a) and b)

8.3.2.5 Window Ventilation

Provision for passenger saloon ventilation should be provided by opening (hopper vent) side windows.

On single deck buses such windows shall be provided at all full size bays.

On double deck buses such windows shall be provided:

- Lower deck
 - At all full size bays
- Upper deck
 - At foremost full size bay, nearside and offside
 - At rearmost full size bay, nearside and offside
 - At one other full size bay, nearside and offside

At least 11 % of the total surface side glass area (excluding door glass and destination glass) should be of the open hopper type, providing an open area air gap of not less than 3.5 % of total glass area.

A number of these opening windows must be capable of being fixed in a fully open position. The requirement minimum is;

- Lower deck
 - Foremost window
 - Rearmost window, nearside and offside
- Upper deck
 - Foremost window, nearside and offside
 - Rearmost window, nearside and offside



8.3.3 HVAC Test Switch

An HVAC system test switch shall be fitted to temporarily override the automatic thermostatic controls and driver selectable cab controls. Activation shall force the drivers cab and passenger saloon HVAC system to either 100% heat or 100% cooling output, depending upon selection. All HVAC fan blowers and heat/cooling output sources shall be activated. The test mode selection shall be active for 10 minutes, after which time the system must automatically deactivate and return saloon to automatic thermostatic, and cab to driver control. The test switches shall be located within the passenger saloon, behind a panel that is easily accessible and removable without specialist tools, such as behind a panel above a saloon door. The switches shall not be located within the driver's cab.

- If “maintenance only” shut off valves are required, they must utilise an independent hand tool and not be capable of being adjusted by lever or hand operation. The system should be designed to enable a full operational check of component functions and settings in the regular service routine.
- Each of these systems shall be integrated into a fully automatic heating and ventilation system that avoids operational conflicts in accordance with Attachment 9.
- Any maintenance or testing function must be automatically reset to its full operational condition after every restart.
- A pre heat capability to soak upper and lower deck interior areas with forced heated air to warm up the side panels, hand poles and seating surfaces may be used.

8.3.4 Thermal Insulation

All side walls and roof areas shall be fully insulated. Moreover, the floor surface should also be insulated.

To reduce the coefficient of heat transmission as much as possible, suitable materials shall be used and/or suitable design measures like coated panes or insulation glass shall be taken. In addition to this, insulation materials shall comply with the requirements set out in LBSL BVS Attachment 6: Standard for The Fire Retardant Properties of Bus Materials.

To achieve sufficient comfort, the surface temperatures of the single surfaces in the bus shall deviate as little as possible from the average interior temperature.

8.4 Seating

Operators should provide generous seat pitches throughout the bus to permit ease of movement and local stowage of hand luggage. Particular attention to generous spacing should be given to the seats in the upper saloon on double-deck buses. General arrangement drawings and capacities shall be agreed with LBSL by the OEM as part of General Assembly drawings uploaded to the TfL BVS Database. and should not be adjusted without prior approval from LBSL.



Individual passenger seats shall be installed at all seating positions and shall be no less than 440 mm wide, including moulded panel areas, except when identified and accepted on drawings approved by TfL and uploaded to the TfL BVS Database.

Seats shall be equipped with securely fixed, replaceable seat and back pads. These seat and back pads shall be of sufficient thickness and quality to provide a good quality of comfort and support for passengers.

Any seat backs and pads that are moulded into body panels must provide equivalent levels of comfort to that provided by the main saloon seating.

8.5 USB Charging Points

For all new buses, USB power supply and charging points should be provided at all seating areas and the designated wheelchair area and shall be capable of charging typical mobile phones and tablet computers. They should where possible be mounted in seat backs.

Installation of USB power supplies must be such that:-

- Each individual plug-in port must incorporate an inline fuse
- Each plug-in port maintains the seat back profile, and does not protrude from the panel surface panel by more than 4mm
- The plug-in port must not protrude from any panel surface by more than 4mm
- The plug-in port is finished in a colour that would not be mistaken for a bell push
- They are tamper proof
- They have a minimum IP54 rating
- They are E marked
- Plug- in ports must not be located within any head impact zones (such as the top of the seat in front; this would be classed as a hazard in the Occupant Friendly Interior Assessment in Attachment 34)
- The plug-in port for the designated wheelchair area must be accessible for the wheelchair occupant when in the recommended travelling position.



9 Aesthetics & Image

Closed circuit television (CCTV) security cameras, monitors, digital recording devices, safety enhancements, iBus and ticketing systems are considered an integral part of the bus design and the necessary visual attention to their design and installation detail must be taken. Wiring looms should be integrated by the OEM's where possible.

10 Route and destination board, signs and notices, livery, advertising etc

10.1 Destination and Route Number displays

Buses shall be equipped with power operated front, side and rear destination displays simultaneously controlled by one route / destination selection unit in the driver's cab. It is essential that all displays are correctly positioned and coordinated whilst a bus is in service, regardless of the equipment type used, and this is the Operator's responsibility. It shall be possible for the driver to easily identify from the cab seat that the front display is correctly positioned. Dimensions for all display units shall comply with the requirements of Attachment 10.

All destination displays shall use Transport for London's New Johnston condensed font in white on a black background including out of service or any other passenger information.

All destination displays shall be fully back illuminated by LED type lighting systems and automatically illuminated at all times. Light sources shall be positioned at the horizontal centreline of each blind, providing an even distribution of illumination across the full blind area.

No light illumination gaps shall be visible around any point on the displays from the exterior view of the bus.

No logos, signs or abbreviations are permitted on the destination display. The approved ultimate and intermediate display wording will be provided by LBSL by the formal Route Record.

Where double letters or numbers occur on any display, additional separation space shall be provided to improve identification.

Blind jockey rollers or other devices must be utilised when necessary to keep blinds taut and as close as possible to the glazing line

All displays shall be equipped with an exterior anti-vandal impact and anti reflection overlay.

The front route display shall show the ultimate destination with a single track number in a side by side arrangement.

- The front visual display shall be no smaller than that defined in Attachment 10.



- The ultimate destination shall be displayed at the maximum height/size available. A proportional reduction in font size is permitted only where necessary to accommodate long destination points.
- The ultimate destination sight size (visible area) shall not be less than 1160mm in width and 330mm in height.
- The route number shall utilise the full depth available from the display height and shall have a sight size of not less than 450mm in width and 330mm in height.
- The destination shall display the wording defined in the Route Record issued by LBSL only, no intermediates, logos, qualifiers, curtailment points or any other information that is not part of the approved wording shall be shown

The nearside route display must have the ultimate destinations and single track number in a side by side arrangement. The route number must be shown to the forward most point of display.

- Equipment may be a combined single track or split number but in either case must achieve the dimensions defined in Attachment 10
- The ultimate destination and route number shall utilise the full first window bay width
- The side visual display shall be no smaller than that defined in Attachment 10
- The ultimate destination sight size shall not be less than 687mm in width and 210mm in height
- The route number shall utilise the full depth available from display height and the sight size shall not be less than 270mm in width and 210mm in height.
- The height of the horizontal centreline of the characters in the display shall not be less than 1200mm or more than 2500mm from ground at the normal bus ride height.

The Rear route display shall display a number identical to the independent front route number display.

10.2 Running Numbers

Running number boards (if utilised) must be positioned and displayed in a manner that cannot be misinterpreted as a route number. They should be to the sides of the vehicles on the bodywork, or if in the windscreen area in a position that does not in any way obstruct the drivers' view.

- The character font must be yellow on black
- Font size shall not be greater than 200mm in height
- The display shall be of a professional appearance.
- Soft print copy taped or positioned adjacent to windows is not permitted



10.3 Other Internal and External Signs and Notices

Exterior and interior notices are provided by LBSL as listed in the London Buses – Bus Graphics Standard (<https://content.tfl.gov.uk/london-buses-bus-graphics-standard-issue03.pdf>), and must be fitted in the appropriate positions.

All such notices shall be as defined in the booklet Manufacturers' Application Procedure. These notices may be obtained by bus OEM or operators FOC from the current supplier Stewart Signs.

Specific operator notices shall not be permitted, for example

- Operator specific Welcome Aboard notices (on driver's cab door, panels, glass, or in floor covering)
- No notices, information, legal address, recruitment or any other advertising material is permitted on the interior or exterior of any window without prior permission of LBSL
- CCTV advisory notices
- Audio advisory notices

Notices provided by operator must be fitted in the appropriate positions:-

- Fleet numbers and operator identification code shall be marked on the roof. Operator codes shall be as defined in Attachment 13 with black cut out lettering of operator code over fleet number, character New Johnston Bold font 350mm in height, positioned on centre line of bus, transversely at rear of white roof section.
- Operator logo positions shall be as agreed in management document illustrations for each operator
- All external and internal legal notices, shall be in a single contrasting colour, cut out type if appropriate.
- All notices and signs to be in Transport for London's "New Johnston" bold or medium font unless legally required otherwise

10.3.1 First Responders Vehicle Propulsion Identification Symbols

Recommendations have been made by the fire service to ensure that the type of propulsion of each bus is clearly stated. Identification of propulsion systems will help to maximise the safety of staff, customers, and first responders during an incident.

- All Propulsion Identification Symbols must comply to ISO 17840-4:2018
- Drivers' daily checks shall include the visual inspection of the easily accessible Propulsion Identification Symbols (not roof), ensuring they are not damaged or missing. Any issues must be reported, in line with operator processes for issue reporting. A lower frequency check for the roof symbol should be undertaken by an appropriate person when the vehicle is off the road.



- If the propulsion system of the bus is changed, modified, or updated, it is the responsibility of the Bus Operator to ensure the identification symbols, Rescue Guide and ERG are updated accordingly.
- No Propulsion Identification Symbols shall be obscured by any livery changes. Any livery change must ensure the symbol is still visible and obvious. As shown in Figure 10_1: if an electric bus is painted orange, the symbol shall have a black background behind it.



Figure 10_1 Examples of acceptable Propulsion Identification Symbol background configurations

All Propulsion Identification Symbols shall be placed and orientated in such a way that the propulsion type can be recognised from all 5 sides of the bus.

Examples are shown in Figures 10_2, 10_3, 10_4 and 10_5.

- Nearside - Located above the front door (if not immediately above the front door, then close to it) as shown in Figure 10_2
- Offside - Located above the driver's cab window (if not immediately above the driver's cab window, then close to it) as shown in Figure 10_3
- Front - Located above the front windscreen on the driver's side as shown in Figure 10_4 (left)
- Rear - Located above the rear window on the non-driver side (if appropriate, this may go on the window blacking that is either side of the rear window) as shown in Figure 10_4 (right)
- Roof – Located at the rear of the bus, within a centralised location below the bus roof identification number as shown in Figure 10_5

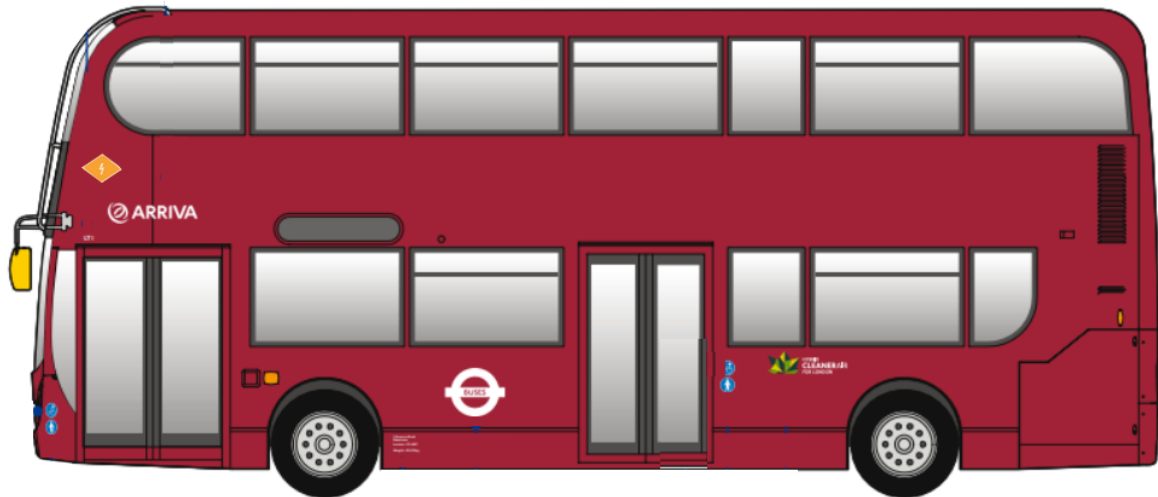


Figure 10_2 Nearside Propulsion Identification Symbol location



Figure 10_3 Offside Propulsion Identification Symbol location

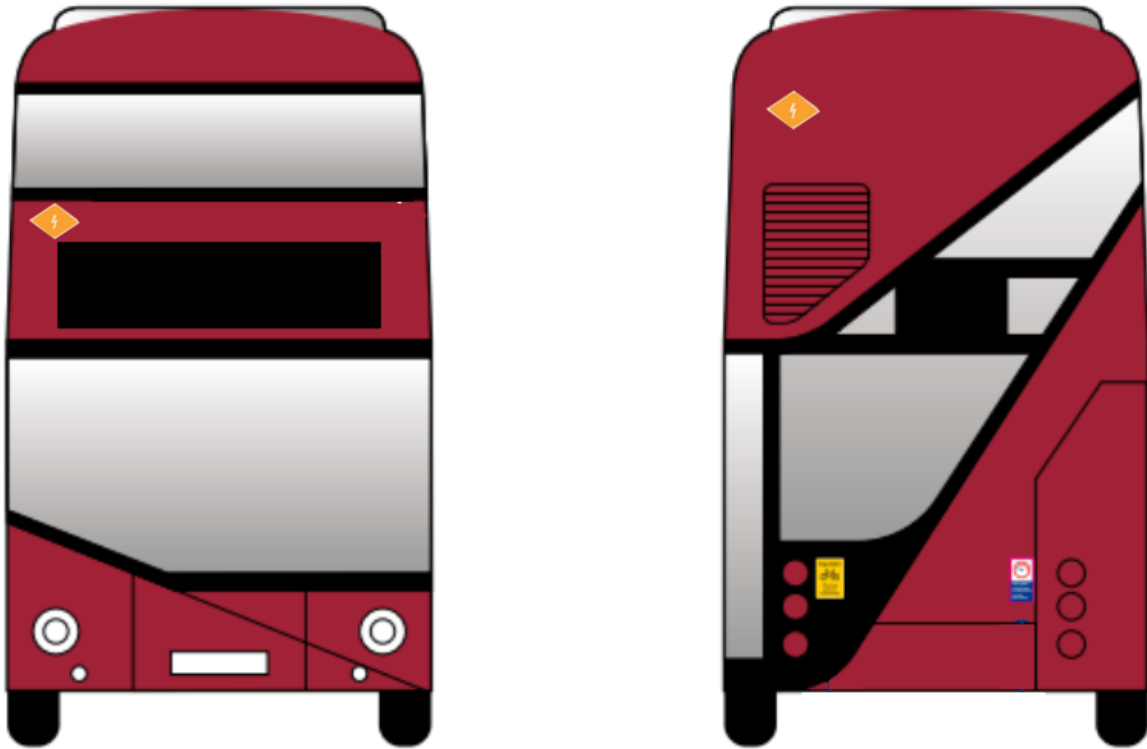


Figure 10_4 Front (left) and Rear (right) Propulsion Identification Symbol location



Figure 10_5 Roof Propulsion Identification Symbol location

- All dimensions of symbols shall be per ISO 17840-4:2018. General recommendations in ISO 3864 shall be followed to ensure the symbol has the appropriate dimensions to be readable and clear from a distance. No distance is given, however a common sense approach should be taken.

10.3.1.1 Specific Labelling Dimensions

⋮

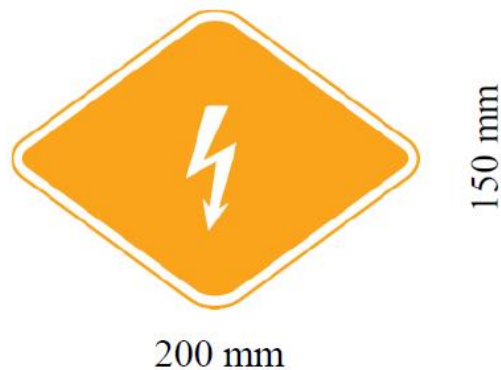


Figure 10_6 Front, Rear and Side Retro Reflective Propulsion Identification Symbol Dimension requirements



Figure 10_7 Roof Retro Reflective Propulsion Identification Symbol Dimension requirements.

- Colours used for type of propulsion are based on ISO 17840-4:2018 and shall also meet TfL's requirement to produce customer information in an accessible format.
- Regulations for retro reflective labels, Regulation No 104 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of retro- reflective markings for vehicles of category M, N and O. Class E shall be applied.

10.3.1.2 Hybrid Vehicles

Only Class B voltage systems may show the hybrid label as per ISO 17840-4:2018. A class B voltage system is classified in Figure 10_8 below.

Class B voltage system: Orange RGB 255, 165, 0
 classification of an electric component or circuit with a maximum working voltage between 30 V a.c. (rms) and 1 000 V a.c. (rms) or between 60 V d.c. and 1 500 V d.c.
 Source: ISO 6469-3:2011

Figure 10_8 Class B Voltage System Classification

A hybrid vehicle that is below 60V is classed as a mild hybrid. The orange hybrid label may not be displayed on any hybrid vehicle below 60V. This information was provided within the ISO 17840 guidance document 'Info Guideline Road Vehicles Bus or Coach'. The propulsion label shown on a mild hybrid must be for the diesel vehicle shown in Figure 10_9

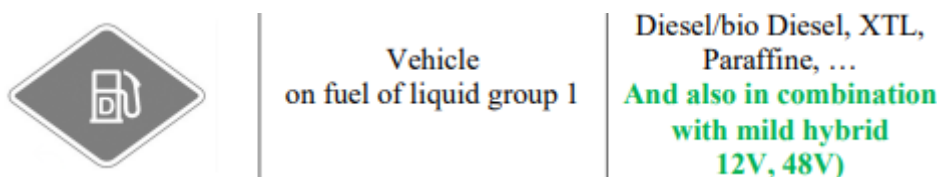


Figure 10_9 Propulsion Identification Symbol requirement for Mild Hybrid vehicles

As per the ISO 17840 guidance document 'Info Guideline Road Vehicles Bus or Coach', only class B voltage may display the hybrid propulsion label as per Figure 10_10 below

	Hybrid Electric Vehicle on fuel of liquid group 2 (Gasoline, Ethanol,)	Only class B voltage Not for mild hybrid (12V, 48V)
	Hybrid Electric Vehicle on fuel of liquid group 1 (Diesel, XTL)	Only class B voltage Not for mild hybrid (12V, 48V)

Figure 10_10 Propulsion Identification Symbol requirement for Class B Voltage (Hybrid) vehicles



10.4 External Advertising

Exterior advertising panels are permitted in the following areas when bus width permits:-

- Off Side
- Near Side
- Rear

All advert panels must be framed with the frame in London Bus Red, except where specific LBSL authority has been given to support a particular activity. Any non-standard, illuminated or special in any way advertising method or advertising display must be approved by LBSL prior to installation.

10.5 Paint, Colours and Livery

All buses shall be painted in a livery that is fully London Buses Red Reference ICI P498FPF3 or exact colour equivalent with the following exemptions

- White roof panels on both single and double decks to interior cove joint (i.e. not visible from pavement level) for heat rejection
- Road wheels are not to be repainted and should remain in the OEM's standard finish

The TfL Roundel is mandatory and should be fitted in accordance with guidance contained in the latest LBSL Bus Graphics Standard (<https://content.tfl.gov.uk/london-buses-bus-graphics-standard-issue03.pdf>)

Should the livery illustration(s) incorporated into your Framework Agreement not include a livery as described above, you should enclose a copy of the rear, front and side illustrations in colour of such a livery. This will be subject to prior approval by LBSL

11 Design for Ease of Maintenance

Closed circuit television (CCTV) security cameras, monitors, digital recording devices, iBus and ticketing systems are considered an integral part of the bus design and the necessary attention to their long term maintenance and repair must be taken into considering when they are installed. Wiring looms should be integrated by the OEM's where possible. It is imperative that the necessary practical detail of assessing these components for maintenance purposes is taken into account.

Design and selection of materials utilised must facilitate ease of cleaning and be maintained to a satisfactory level of appearance throughout the in service bus contract period.