



# **LONDON BUS SERVICES LIMITED**

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Specification for new buses

Version 2.1

Issued December 2020

Effective from Tranche **734**

**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.

<b>Version</b>	<b>Published</b>	<b>Date</b>	<b>Details</b>
2.1	TfL	December 2020	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.
			14	4.3.3 Intelligent Speed Assistance (ISA)	Clarification of map updating, definition of warning Human Machine Interface (HMI) and symbol.
			19	4.3.4.2 Camera Monitor System (CMS): Reversing	Clarification of certification and about Reg 46.
			24	4.3.5.2 Accelerator Light	Clarification of activation levels, and auditory warning.
			27	4.3.5.3 Brake toggle system	Clarification of certification, and failure warning.
			28	4.3.5.4 Pedal acoustic feedback system	Description of goals added.
			29	4.3.6 Runaway bus prevention	Driver input and maintenance requirements clarified.
			30	4.3.7 Halt Brake	Moved to separate section, maintenance checks added.
			30	4.4.1 Acoustic Conspicuity	Requirements on hybrid vehicle added, notes about developments, diagrams showing speaker location, and update details added.
			37	4.5.6 Flooring and Slip prevention	Requirements for new materials added.
			41	4.6.4 VRU Frontal Crashworthiness: Wiper Protection	Wipers defined in relation to bus dimensions.
			45	6.1 Vehicle capacity	Clarification of non-conforming vehicle dimensions, and wipers in relation to dimensions.
			57	8.3 Heating, Ventilation & Air Conditioning (HVAC)	Clarifications made.



				All attachments relevant to above	Updated to reflect changes to the spec.
July 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 <sub>15</sub> 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 <sub>15</sub> 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.



December 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 <sub>15</sub> 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





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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 CO<sub>2</sub> 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.  
[REDACTED]@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
<b>Requirements</b>	All	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
<b>Safety</b>	4.1 Fire	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
	4.2 Security	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
	4.3.1 Driver Assist: Acceleration	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
	4.3.2 Driver Assist: AEB	<i>Not Required</i>	<i>Trial Only</i>	Preferred	Preferred	Preferred	<b>Required</b>
	4.3.3 Driver Assist: ISA	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
	4.3.4.3 Direct & Indirect Vision: Direct vision score (DVS)	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>
	4.3.4.3– Direct & Indirect Vision: Enhanced total Bus vision score (BVS)	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	<b>Required</b>
	4.3.4.4 Direct & Indirect Vision: Camera Monitor System (CMS): Mirror Replacement	<i>Not Required</i>	<i>Not Required</i>	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.3.4.1 Direct & Indirect Vision: Blind spot mirrors	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	Not Required	Not Required	Not Required	



4.3.4.2 Direct & Indirect Vision: Camera Monitor system (CMS) Reversing	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.3.4.5 Direct & Indirect Vision: Front & Nearside Blind spot warnings	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	<b>Required</b>
4.3.5.3 Driver Assist: Pedal Application Error – Brake Toggling	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>
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>	<b>Required</b>	<b>Required</b>
4.3.5.2 Driver Assist: Pedal Application Error – Accelerator light system (ALS)	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
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>	<b>Required</b>	<b>Required</b>
4.3.5.6 Driver Assist: Pedal Application Error – AEB logic	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	<b>Required</b>
4.3.6 Driver Assist: Runaway Bus Prevention	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.3.7 Driver Assist: Halt Brake	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.4.1 Partner Assist: Acoustic Conspicuity - AVAS	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>



4.4.2 Partner Assist: Visual Conspicuity	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.5.1 – 4.5.3 Occupant protection: Stairs, Seats, & Handrails	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.5.4 Occupant protection: Guards	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.5.5 Occupant Protection: Bus interior safety – Level 1 requirements	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.5.5 Occupant Protection: Bus interior safety – Level 2 requirements	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	Preferred	<b>Required</b>
4.5.6 Occupant protection: Slip prevention	<i>Not Required</i>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>	<b>Required</b>
4.6.1 Partner Protection: VRU frontal crashworthiness – Minimum geometry	<i>Not Required</i>	Preferred	Preferred	Preferred	Preferred	<b>Required</b>
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>	Preferred	<b>Required</b>
4.6.3 Partner Protection: VRU frontal crashworthiness – Energy absorption	<i>Not Required</i>	<i>Not Required</i>	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>
4.6.4 Partner Protection: VRU frontal crashworthiness – Wiper	<i>Not Required</i>	Preferred	Preferred	<b>Required</b>	<b>Required</b>	<b>Required</b>





	protection						
	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
<b>Environment</b>	All	Required	Required	Required	Required	Required	Required
<b>Operational Efficiency</b>	All	Required	Required	Required	Required	Required	Required
<b>Accessibility</b>	All	Required	Required	Required	Required	Required	Required
<b>Occupant Experience</b>	All	Required	Required	Required	Required	Required	Required
<b>Aesthetics</b>	All	Required	Required	Required	Required	Required	Required
<b>Signs</b>	All	Required	Required	Required	Required	Required	Required
<b>Maintenance</b>	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, 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.

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**

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.

## **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
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	
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	



Description		Code	
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

Double-deck buses shall be equipped with a concealed smoke detector in the upper deck rear seated area. A warning device shall inform the driver of activation of this detector as part of the audible information provided by the FSS.

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.

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 demonstrated in accordance with the Communication Test Protocol, [Attachment x (*under development*)].

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  $1.2\text{m/s}^2$  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.

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

- It shall be tested in accordance with LBSL’s Automated Emergency Braking Assessment Protocol (Attachment 15) and it must attain a performance score greater than zero.
- The bus OEM must produce documentary evidence for LBSL approval to demonstrate that on average they would expect false positive activations in mixed London traffic less frequently than once every [600,000]km per vehicle.
- The bus to which AEB is fitted must have been assessed in accordance with the LBSL’s Occupant Friendly Interiors Assessment Protocol (Attachment 34) and have achieved the Level 1 requirements, with a score of  $\leq 80$  for the lower





saloon, and where applied to double deck vehicles, a score of  $\leq 8$  for the upper saloon.

- 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

#### 4.3.3 **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

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 one of the following two performance specification options;

- Option 1
  - There shall be no intervention by any vehicle system to enforce a speed reduction.
  - The system will impose the speed limit of the previous zone until the driver brings the vehicle below the prevailing speed limit.
  - When the vehicle drops below the prevailing speed limit, the ROM shall be actively, limiting the vehicle speed . This is to prevent unpredictable behaviour by the vehicle.
  - Any vehicle speed in excess of the prevailing limit, at any time, should be notified to the driver, via a flashing speed limit symbol (section 4.3.3.3).
  
- Option 2
  - 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 30.0m 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 (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
- Any other condition resulting in the condition of ROM not being implemented

The ISA symbols shall be:



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



The speed limit indicator is mandatory for both Option 1 and Option 2 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 1-5Hz 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:
  - Forward boundary: parallel to the frontal plane of the bus and 0.5m rearward of the driver's ocular reference point



- Rearward boundary: parallel to the frontal plane of the bus and 4m rearward of the driver's ocular reference point
- 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
- 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:
  - Forward boundary: parallel to the frontal plane of the bus and 0.5m rearward of the driver's ocular reference point
  - Rearward boundary: parallel to the frontal plane of the bus and 4m rearward of the driver's ocular reference point
  - 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
  - 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 (Class I field of view) Camera-Monitor Systems (CMS) compliant with UNECE Regulation 46 for technical quality of view.

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*

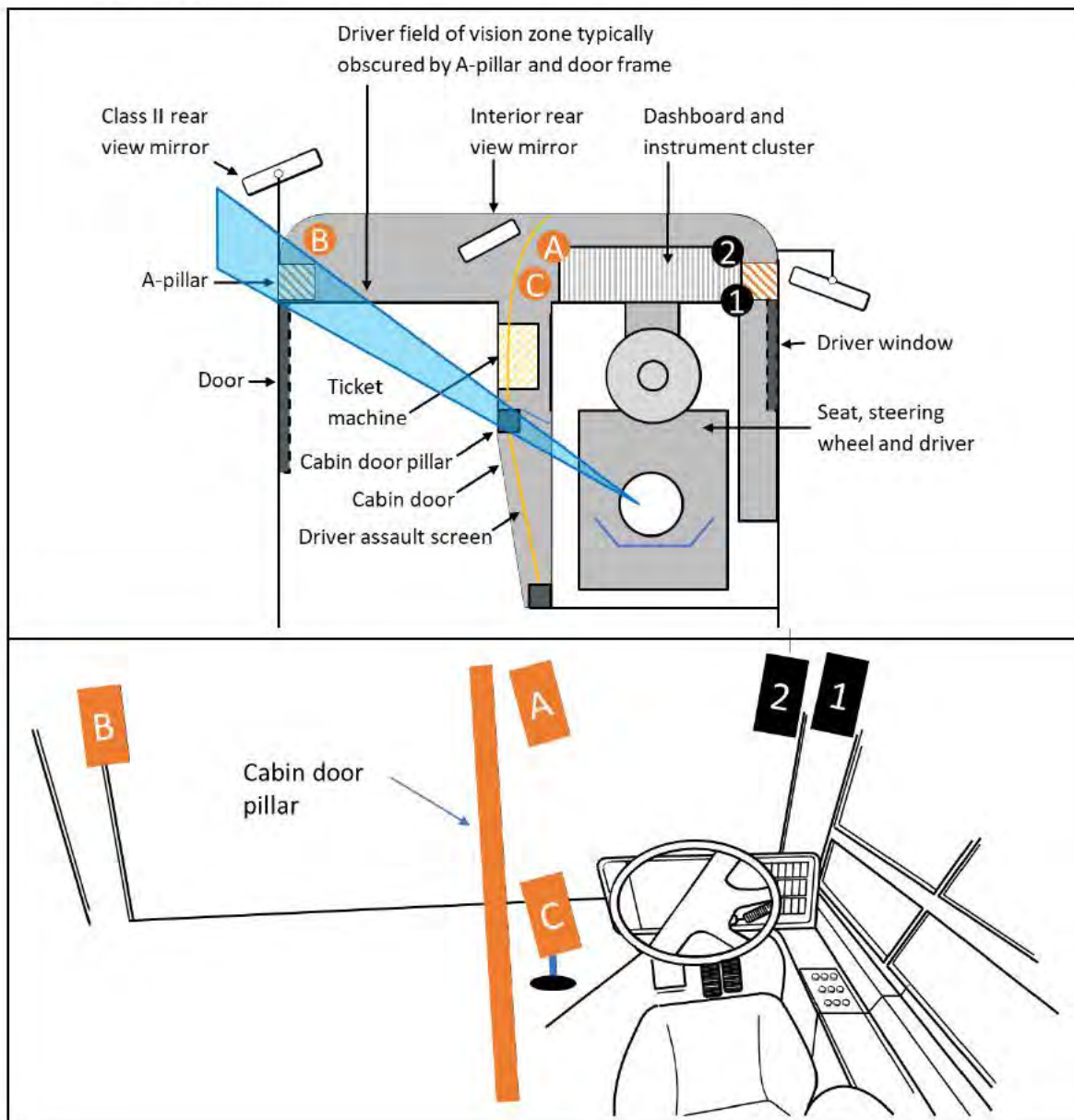
All buses shall use Camera-Monitor Systems (CMS) that are compliant with UNECE Regulation 46 to replace physical mirrors on the bus, at least for the Class II and IV fields of vision (FOV) defined by the same Regulation and the blind spot FOV defined by the bus vehicle specifications for blind spot mirrors (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 4-1, 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 4-1, 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 4-1. 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:

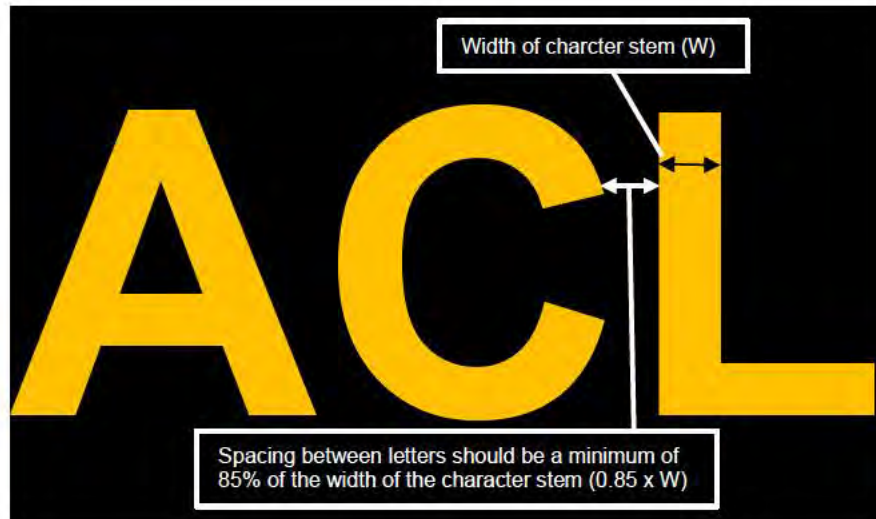
- maintenance and repair is as convenient as possible.
- it complies with to the requirements set out in UNECE Regulation 121. This makes reference to ISO 2575:2004, which should be used as additional guidance if needed. If further guidance is still needed, then the guidance set out in the NHTSA Human 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 4-2. Pedal indicator icon design**

- The icon must be displayed on a minimum pixel matrix of 32x32.
- The icon shall be yellow on a black background.
- All text must be presented on a minimum character matrix of 7x9.
- 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  $\leq 80\%$  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 confusion 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 doors were last opened or the ramp last deployed.

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  $\pm 1\%$ .

The Brake Toggle System shall

- operate automatically without the need for the driver to activate or deactivate the system.
- be capable of operating in all driving scenarios.
- be tested in accordance with the protocol defined in Attachment 26 and achieve a score of 7.
- have no adverse effects on other vehicle operations and systems.
- ensure that the halt brake will only release after the brake pedal is depressed and then released. As such, the vehicle will be incapable of movement until the brake has been applied and released, even if the throttle pedal is depressed.



- release the halt brake no more than 500ms after the driver had released the brake pedal and applied a depression of the accelerator by > [10%].

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 has left the driving seat without applying the park brake.

The system shall:

- Act on the park brake and not the service brake such that it is not possible for air leakage over time to result in bus movement.
- As a minimum automatically detect driver seat pressure or driver input, driver cabin door status, passenger door status and park brake activation status.
- Be tested in accordance with the protocol defined in Attachment 28 and achieve a score of 12 in each checklist to result in a 'Pass' certification.
- Not activate in a situation where the bus is already intentionally in motion (moving >5mph and driver in seat). The system shall not act as an emergency brake if the driver loses control of the vehicle while driving.

The seat sensor, or some type of driver input (such as pedal input), is specified as a measure of whether the driver is present in the cab, and relying only on the cab door being shut is insufficient. If some other means to identify the driver presence in the cab is technically preferable by an OEM then this may be submitted with evidence and schematics for consideration by LBSL.

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.





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.

#### **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 lowered. It shall not activate in any other circumstances. Once the halt brake has been activated the bus shall remain stationary until the driver takes action to deliberately cause the bus to move by engaging the accelerator pedal, regardless of the status of the bus doors, bus kneeling or passenger ramp. Whether by the halt brake or by other means (e.g. creep torque.), whatever method is employed shall be effective on all urban roads regardless of road gradient.

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.]

### **4.4 Partner Assist**

#### **4.4.1 Acoustic Conspicuity**

Buses shall be fitted with a reversing alarm that issues an audible warning of “white sound” whenever reverse gear is selected, and the vehicle is in motion. The system shall incorporate a driver’s cab time delayed isolation override. This requirement is in addition to the reversing requirements of UNECE Regulation 138.

All quiet running buses of categories M2 and 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.

TfL has designed a unique Urban Bus Sound to be used by 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 sound components must be representative of the original files in all specified operating conditions to comply with this standard.



Ver. 1 [Current operation]

The Core sound shall be played at all times on bus start up.

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.

Ver. 2 [Alternative operation]

The Core sound shall be played at all times on bus start up.

In addition to the Core sound, playback of the Beacon sound shall begin immediately when the bus begins to move regardless of whether the bus is moving forwards or backwards. The Beacon sound shall continue playing on a loop while the vehicle is moving.

When the bus comes to a stop the Beacon sound is to continue playing until it has completed the current playback loop.

**4.4.1.2 Sound Amplitude**

When both the Core and Beacon sounds are playing the AVAS must achieve both the maximum and minimum sound levels ( $L_{MAX, FAST}$ ) defined in Attachment 30, Appendix B when measured at the front plane of the bus 2m from the centreline of the bus on both sides, as defined in Appendix 3 of UNECE Regulation 138.

When reversing the bus must produce a minimum overall sound pressure level of 47 dB  $L_{MAX, FAST}$  at the rear plane of the vehicle 2m from the centreline of the bus on both sides.

The sound shall be emitted from the front of the vehicle at all times with the sound distributed evenly in a 180-degree arc from the central position at the front plane of the vehicle. This is to be shown by  $L_{MAX, FAST}$  within a tolerance of  $\pm 1.5$ dB measured at 10 degree increments.

Ver. 1 (Flat level, subject to trial)	The $L_{MAX, FAST}$ of the Urban Bus Sound measured 2m from the centreline and 2m ahead of the front plane of the bus must achieve the minimum $L_{MAX, FAST}$ and frequency profile defined in Appendix B (Attachment 30) between 0 and [20kph].
Ver. 2 (Amplitude varies with speed, subject to trial)	The $L_{MAX, FAST}$ of the Urban Bus Sound measured 2m from the centreline and 2m ahead of the front plane of the bus must achieve the minimum $L_{MAX, FAST}$ and frequency profile defined in Appendix B (Attachment 30) between 0 and 5kph.  The amplitude must increase at a rate of 3dB(A) for a



	doubling of speed between 5 and [20kph].
Ver. 3 (Geo-fencing, subject to trial)	<p>For speeds up to [20kph] 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 level based on the above parameters (see Section 4.3.3. for ISA Specification).</p> <p>The <math>L_{MAX, FAST}</math> measured 2m from the centreline and 2m ahead of the front plane of the bus on the kerb side of the bus must be equal to the value in the sound level map.</p> <p>The amplitude shall transition smoothly between roads taking no more than 3 seconds to transition from one value to another.</p>

At speeds above [20kph] the sound must be attenuated decreasing linearly so that the AVAS stops sounding at [22kph].

When the bus is stationary the Driver's Cabin must not be exposed to  $L_{MAX, FAST}$  above [60dB(A)] as a result of sound from the AVAS sounders.

#### **4.4.1.3 Frequency Modulation**

The pace/playback speed and frequency content of the Urban Bus Sound must increase at a rate of 0.8% per kph as the bus accelerates and decrease at the same rate as the bus decelerates.

#### **4.4.1.4 Frequency Profile**

The Urban Bus Sound, when measured 2m from the centreline and 2m ahead of the front plane of the bus on the kerb side, must achieve a frequency profile between the minimum and ideal values defined in Attachment 30 for both the maximum and minimum amplitude conditions.

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.

#### **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.

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

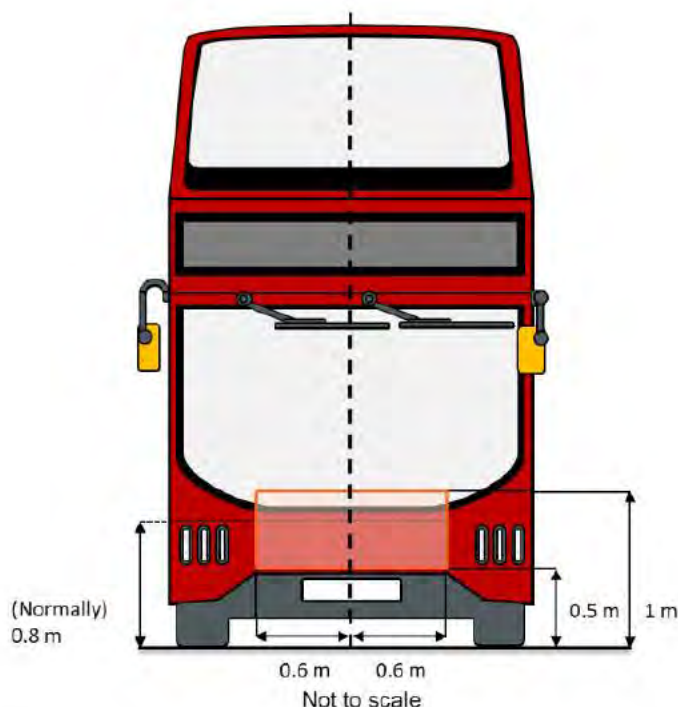
A complete functionality self-check of the AVAS must take place on bus start-up, testing hardware and software functionality. The system shall provide the driver with an audible notification that it is operative and free of defects. The Driver shall be informed should the AVAS fail at any time while the bus is switched on by means of a notification.

The AVAS system shall incorporate a failure mode to allow it to operate at the minimum designed sound level in the event that external signals necessary for setting the output amplitude are not received.

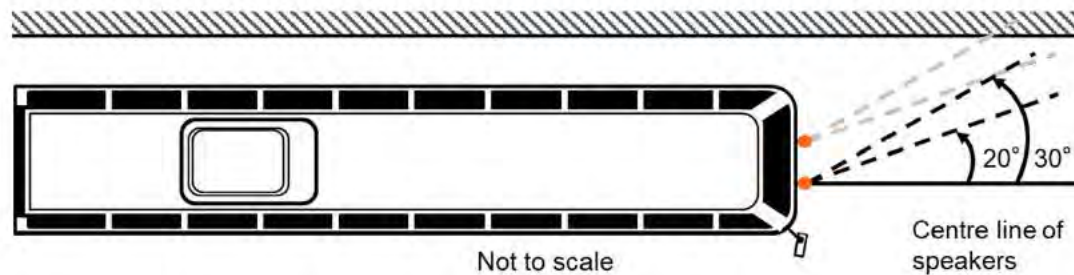
It shall be possible for TfL or the bus operators to upload new sounds into the AVAS hardware, either remotely or with minimal intrusion of the bus so as to prevent buses being unnecessarily taken out of service.

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 from control and power cabling.

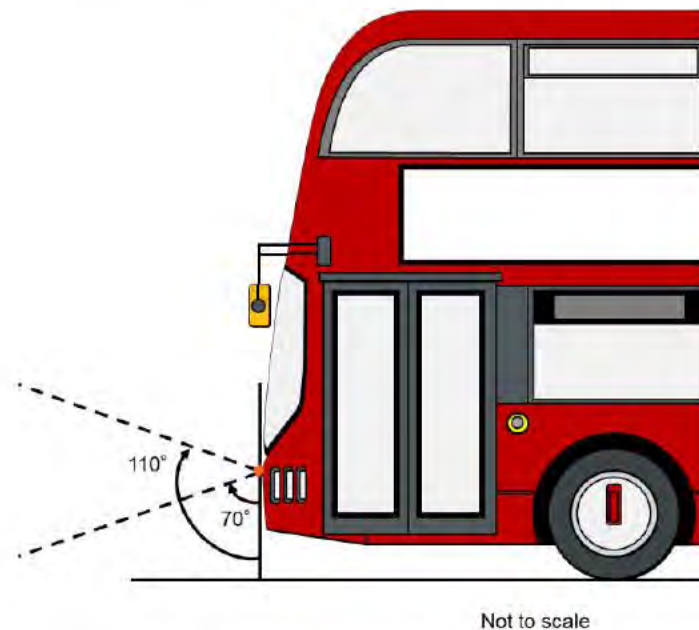
Any Digital Signal Processing shall not rely on an external computer for its operation and shall have no moving parts. The DSP configuration shall incorporate resilient features such that the failure of one part of the DSP does not render the whole system inoperable.



The sounders must be installed such that they have an unobstructed sound path in the direction they are intended to be effective.



The sounders shall be positioned one on each side of the bus front. Each sounder shall have a vertical beamwidth/directivity pattern in the range 70° to 110°.



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 230mm, and a step riser of not more than 245mm 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 saloon, 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 form a smooth tube of between 30mm and 35mm 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 seats in the lower saloon and at alternate seats in the upper saloon.

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 PSVAR 2000.
- 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 Attachment 5.

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 75dBA, 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 25mph).

#### 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:

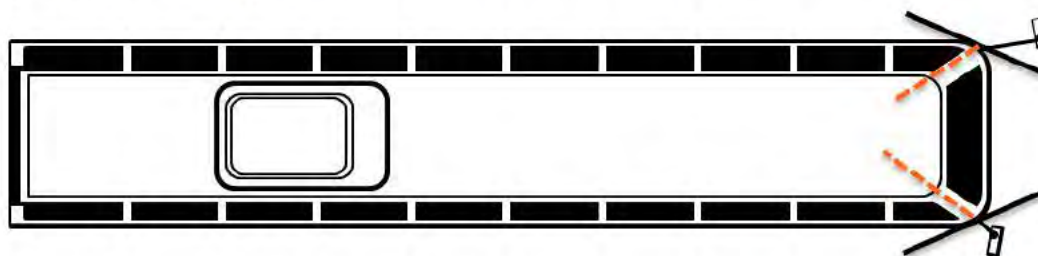
- Minimum vertical rake angle of  $[1]^\circ \pm 0.5^\circ$  tested at the worst-case location between vertical heights of  $[0.75] - [1.2]$  m from the ground plane and the side reference lines; and
- Minimum vertical rake angle of  $[4]^\circ \pm 0.5^\circ$  tested at the worst-case location between vertical heights of  $[1.2]-2.0$  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  $236\pm 5$  mm x  $236\pm 5$  mm rectangular plane, with its centre placed against the surface of the bus at the test location.

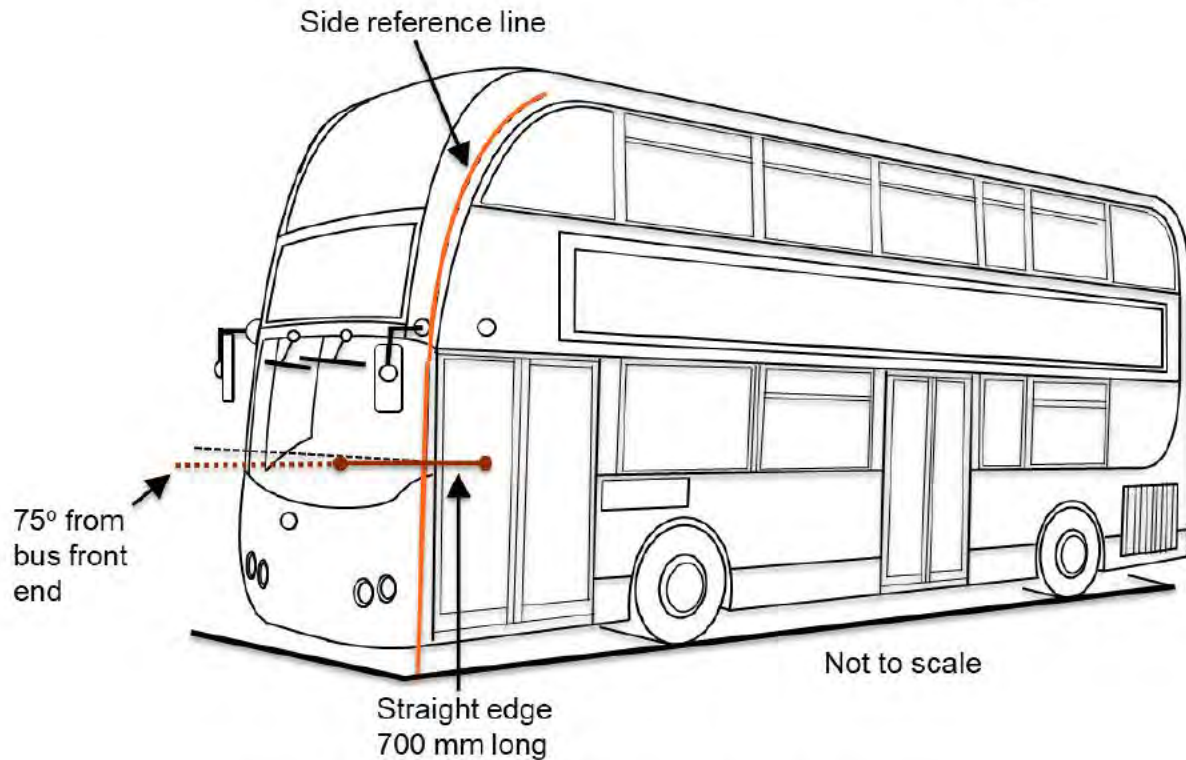
Wraparound windscreen and bumper bus front end designs, where the glazed areas and bumper at the front-end edges are curved and the A-pillars are located rearward of the bus front end, are required. The minimum requirements shall be:

- A radius of curvature of at least 150mm tested in the horizontal plane and at the worst-case location between lateral positions of 0-150mm inboard from each side reference line and between vertical heights between  $[0.75]-2.0$  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  $75^\circ$ , is traversed rearwards to contact the sides of the bus front end (Figure 4-4 and 4-5).



**Figure 4-4: Side reference line – plan view**



**Figure 4-5: 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°.



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 (HIC<sub>15</sub>) 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 (HIC<sub>15</sub>) 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 in Attachment 5.

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.



## **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 and ancillary systems for long periods whilst stationary, an automatic ignition shutdown system shall be incorporated. The engine and any noise generating ancillary systems shall be automatically shut down when the bus is stationary for 2.5 minutes, with the park brake applied. The driver shall be provided with an audible 1 minute warning of the shut down and have the facility to override back to the 2.5 minutes of stationary operation.



### **5.3 Carbon dioxide emissions**

The bus OEM shall, for all hybrid buses and zero tail-pipe emission buses, 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 fuel, oil and tyres used during operations.

Engine cooling fans shall be environmentally efficient. Hydraulically driven engine cooling fans 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 scheduled in Attachment 5. 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 68kg 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.

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

## **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 1200mm, 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 1030mm 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 300mm in height above the antenna mounting point must be spaced at least 1000mm away from the antenna.
- For objects that are between 300 and 500mm in height, the minimum spacing must be increased to 2000mm.
- If the item height exceeds 500mm, please contact LBSL's Radio Infrastructure Engineer.



No electronic equipment may be located in the roof space directly underneath or within 500mm 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 approx 490mm to achieve this

All of these seats will be fully defined on the approved seating layout as scheduled in Attachment 5.

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 1000mm 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 75dB(A), when measured at 1.25m height from the exterior ground, on the centre line of the exit door at a distance of 1.5m.
- Automatically undertake a partial operation extending cycle of approximately 50mm 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 25mm and ideally by 35mm. 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  $\geq 2000\text{mm}$  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 defined in Attachment 5.

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



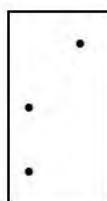


A manual or automatic security arm shall not be used to replace the floor to ceiling handrail.

*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 without LBSL's consent.

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

- Seats, 150mm 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)**

Passenger saloon general 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.

The heating and air conditioning for the bus shall keep the driver cab air completely separate to the passenger saloon air. This should be fed by exterior fresh air; there shall be no mixing or recirculation of the drivers air supply with saloon air by design intent. Evidence of this shall be provided as part of the Assessment Protocol detailed in Attachment 9.

A separate air conditioning system for the driver's cab shall be provided and shall be fully controlled by the driver.

A cab screen demisting system shall be provided and shall be fully controlled by the driver. It shall operate independently from the saloon heating, upper deck cooling or cab air conditioning. This should be fed by exterior fresh air; there shall be no mixing or recirculation with saloon air by design intent. The windscreen should demist effectively and equally on both sides of the driver assault screen partition.

In order to maintain safe CO<sub>2</sub> levels inside the cab, the cab ventilation system shall provide high standards of indoor air quality which will be provided by a demand controlled ventilation system that shall automatically keep CO<sub>2</sub> levels in the cab below 800 ppm (or, 400 ppm above average outdoor values in London, whichever is the lowest) at all times. Alternatively, a continuous fresh air feed of at least 10 litres per second shall be supplied that cannot be disabled by the driver while the cab windows are closed.

The ventilation system for the saloon shall be fitted with a particulate matter filter or air cleaner of MERV of not less than 11 in accordance with ASHRAE Standard 52.2, and as described in ASHRAE Standard 62.1-2019.



All buses shall be equipped with:

- A fully automatic heating and ventilation system with saloon operational temperatures set as defined in Attachment 9.
- Blown air heating and ventilation system to both lower and upper deck where appropriate. The system should provide a good circulation of air throughout the length of the bus interior. Convection only systems are not acceptable.
- Fully automatic thermostatic control of the system. The thermostatic sensors should be positioned to reflect the interior, upper and/or lower deck temperature of the bus and be in a tamper proof location. Heated or unheated air should be circulated throughout the bus dependant on interior bus temperature. It should not be necessary for the driver, maintenance teams or any other parties to adjust or set the heating or ventilation system during variations of temperature, such as during summer and winter periods. If engine bay “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.

Double-deck buses shall also be equipped with an air-cooling system for the upper saloon with operational temperature set as shown in Attachment 9. This system must be capable of reducing the internal saloon temperature by 5°C when subject to an interior saloon temperature of 28°C by inputting at variable fan speeds suitable quantities of conditioned and cooled air via saloon length ducting. Compliance with this requirement shall be demonstrated by means of a LBSL pull down test as defined in Attachment 9.

Each of these systems shall be integrated into a fully automatic heating and ventilation system that avoids operational conflicts in accordance with Attachment 9.

The driver shall not be able to override the automatic heating / cooling systems for the passenger section of the bus. Any maintenance or testing function must be automatically reset to its full operational condition after every engine restart.

In addition, zero emission bus types must have a zero-emission heating solution (i.e. diesel heaters are not permitted).

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.

## **8.4 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 Attachment 5 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 440mm wide, including moulded panel areas, except when identified and accepted on drawings in Attachment 5

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 Mobile phone and tablet 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 taught 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 (<http://content.tfl.gov.uk/london-buses-graphics-standard.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

## 10.4 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 (<http://content.tfl.gov.uk/london-buses-graphics-standard.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.