



# **LONDON BUS SERVICES LIMITED**

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Specification for new buses

Version 1.1

Issued May 2019

Effective from Tranche 670



**Preface**

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

Where a Vehicle Manufacturer perceives that a particular feature of this document should be changed, this should be raised by the Vehicle Manufacturer with the Approval Authority (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.

Vehicle Manufacturers 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.

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**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.  |
|               |                             |             | 12      | 4.3.3 Intelligent Speed Assistance (ISA)            | Clarification of map updating, definition of warning HMI and symbol.   |
|               |                             |             | 17      | 4.3.6 Camera Monitor System (CMS): Reversing        | Clarification of certification and about Reg 46.   |
|               |                             |             | 20      | 4.3.10.2 Pedal use indicator lights system          | Clarification of activation levels, and auditory warning.  |
|               |                             |             | 21      | 4.3.10.3 Brake toggle system                        | Clarification of certification, and failure warning.   |
|               |                             |             | 22      | 4.3.10.4 Pedal acoustic feedback system             | Description of goals added.  |
|               |                             |             | 23      | 4.3.11 Runaway bus prevention                       | Driver input and maintenance requirements clarified.   |
|               |                             |             | 24      | 4.3.12 Halt Brake                                   | Moved to separate section, maintenance checks added  |
|               |                             |             | 24      | 4.4.1 Acoustic Conspicuity                          | Requirements on hybrid vehicle added, notes about developments, diagrams showing speaker location, and update details added. |
|               |                             |             | 29      | 4.5.6 Flooring and Slip prevention                  | Requirements for new materials added.  |
|               |                             |             | 32      | 4.6.4 VRU Frontal Crashworthiness: Wiper Protection | Wipers defined in relation to bus dimensions   |
|               |                             |             | 36      | 6.1 Vehicle capacity                                | Clarification of non-conforming vehicle dimensions, and wipers in relation to dimensions                                     |
|               |                             |             | 46      | 8.3 Heating, Ventilation & Air                      | Clarifications made  |



|  |  |  |  |                                   |  |
|--|--|--|--|-----------------------------------|--|
|  |  |  |  | Conditioning (HVAC)               |  |
|  |  |  |  | All attachments relevant to above | Updated to reflect changes to the spec |



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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, Class II.

## 1.2 Purpose

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

- Regulatory Compliance
- Safety: TfL and LBSL are committed to Vision Zero and believe that no death or serious injury when travelling in London is either acceptable or inevitable. LBSL's aim is that by 2030 nobody will be killed in a collision involving a bus.
- Environmental Performance: LBSL support the target to reduce the Capital's CO2 emissions by 60% by 2025 and become carbon neutral by 2050. To have a zero emission at tailpipe fleet by 2037. All new diesel powered vehicles 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

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 manufacturers may deviate from the requirement 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 manufacturer 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.

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.

Section 4 of this document specifies TfL's safety requirements for all new vehicles. Those requirements entering the fleet in future years as per the Bus Safety Roadmap for new build buses are highlighted with *italics*.

[ ] indicates TfL's current assumptions for future requirements and will be updated 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.  
(██████████)@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 of those may not be applicable at all, some may be requirements that must be followed if the system is fitted voluntarily, some may be permitted only as part of a controlled trial and some may be ‘preferred’ such that although not mandatory LBSL may employ commercial levers or incentives for buses that do comply with the requirements.

**Table 2-1. Status of actual and planned application of each set of requirements**

| Main section                   | Subsection   | 2018         | End of 2019  | 2020      | 2021         | 2022         | 2024         |
|--------------------------------|--|--------------|--------------|-----------|--------------|--------------|--------------|
| <b>Regulatory Requirements</b> | All  | Required     | Required     | Required  | Required     | Required     | Required     |
| <b>Safety</b>                  | 4.1 Fire   | Required     | Required     | Required  | Required     | Required     | Required     |
|                                | 4.2 Security   | Required     | Required     | Required  | Required     | Required     | Required     |
|                                | 4.3.1 Driver Assist: Acceleration                      | Required     | Required     | Required  | Required     | Required     | Required     |
|                                | 4.3.2 Driver Assist AEB                                | Not Required | Trial Only   | Preferred | Preferred    | Preferred    | Required     |
|                                | 4.3.3 Driver Assist: ISA                               | Required     | Required     | Required  | Required     | Required     | Required     |
|                                | 4.3.7 Driver Assist: Vision – Direct vision            | Not Required | Preferred    | Preferred | Required     | Required     | Required     |
|                                | 4.3.7 Driver Assist: Vision – Enhanced indirect vision | Not Required | Not Required | Preferred | Preferred    | Preferred    | Required     |
|                                | 4.3.8 Driver Assist: Vision – Mirror Replacement CMS   | Not Required | Not Required | Preferred | Required     | Required     | Required     |
|                                | 4.3.5 Driver Assist: Vision – Blind spot mirrors       | Not Required | Required     | Required  | Not Required | Not Required | Not Required |
|                                | 4.3.6 Driver Assist: Vision – Reversing                | Not          | Required     | Required  | Required     | Required     | Required     |



| Main section | Subsection   | 2018         | End of 2019  | 2020      | 2021      | 2022      | 2024     |
|--------------|--|--------------|--------------|-----------|-----------|-----------|----------|
|              | CMS  | Required     |              |           |           |           |          |
|              | 4.3.9 Front & Nearside Alert Systems                                       | Not Required | Not Required | Preferred | Preferred | Preferred | Required |
|              | 4.3.10.3 Driver Assist: Pedal Application Error – Brake Toggling           | Not Required | Preferred    | Preferred | Required  | Required  | Required |
|              | Driver Assist: Pedal Application Error – Pedal standardisation             | Not Required | Not Required | Preferred | Required  | Required  | Required |
|              | 4.3.10.2 Driver Assist: Pedal Application Error – Accelerator light system | Not Required | Required     | Required  | Required  | Required  | Required |
|              | 4.3.10.4 Driver Assist: Pedal Application Error – pedal acoustic feedback  | Not Required | Preferred    | Preferred | Required  | Required  | Required |
|              | Driver Assist: Pedal Application Error – AEB logic                         | Not Required | Not Required | Preferred | Preferred | Preferred | Required |
|              | 4.3.11 Driver Assist: Runaway Bus  | Not Required | Preferred    | Preferred | Required  | Required  | Required |
|              | 4.4.1 Partner Assist: Acoustic Conspicuity AVAS                            | Not Required | Required     | Required  | Required  | Required  | Required |
|              | 4.4.2 Partner Assist: Visual Conspicuity                                   | Required     | Required     | Required  | Required  | Required  | Required |
|              | 4.5.2 – 4.5.3 Occupant protection: Stairs, Seats, & Handrails              | Required     | Required     | Required  | Required  | Required  | Required |
|              | 4.5.4 Occupant protection: Guards  | Not Required | Required     | Required  | Required  | Required  | Required |
|              | 4.5.5 Occupant Protection: Occupant  | Not          | Preferred    | Preferred | Required  | Required  | Required |



| Main section                  | Subsection   | 2018         | End of 2019  | 2020         | 2021         | 2022           | 2024     |
|-------------------------------|--|--------------|--------------|--------------|--------------|----------------|----------|
|                               | friendly interiors – Level 1 requirements                                      | Required     |              |              |              |                |          |
|                               | 4.5.5 Occupant Protection: Occupant friendly interiors – Level 2 requirements  | Not Required | Not Required | Preferred    | Preferred    | Preferred      | Required |
|                               | 4.5.6 Occupant protection: Slip prevention                                     | Not Required | Required     | Required     | Required     | Required       | Required |
|                               | 4.6.1 Partner Protection: VRU frontal crashworthiness – Minimum geometry       | Not Required | Preferred    | Preferred    | Required     | Required       | Required |
|                               | 4.6.2 Partner Protection: VRU frontal crashworthiness – Optimised geometry     | Not Required | Not Required | Not Required | Not Required | Preferred 2022 | Required |
|                               | 4.6.3 Partner Protection: VRU frontal crashworthiness – Energy absorption      | Not Required | Not Required | Not Required | Preferred    | Preferred      | Required |
|                               | 4.6.4 Partner Protection: VRU frontal crashworthiness – Wiper protection       | Not Required | Preferred    | Preferred    | Required     | Required       | Required |
|                               | 4.6.5 Partner Protection: VRU frontal crashworthiness – Mirror Replacement CMS | Not Required | Not Required | Preferred    | Required     | Required       | Required |
|                               | Bus Safety Standard Overall Score  | Not Required | Required     | Required     | Required     | Required       | Required |
|                               | 4.5.7 Door Safety  | Required     | Required     | Required     | Required     | Required       | Required |
|                               | 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 |



| Main section               | Subsection | 2018     | End of 2019 | 2020     | 2021     | 2022     | 2024     |
|----------------------------|------------|----------|-------------|----------|----------|----------|----------|
| <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 approval authority (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 EC WVTA 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 ECE 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 manufacturer 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 in to service.

### 3.2 Test Process

Manufacturers 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 authority and TfL.

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

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

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

Certification runs must be in the same condition and consecutive.

### 3.3 Vehicles types and variants

The variants shall be defined as per directive 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:

| Description                | Code |
|----------------------------|------|
| Advanced Emergency Braking | AEB  |



| Description                          |                                     | Code                    |             |
|--------------------------------------|-------------------------------------|-------------------------|-------------|
| Intelligent Speed Assistance         |                                     | ISA                     |             |
| Direct & Indirect Vision             | 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              | 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               |                                     | RUN                     |             |
| Halt Brake                           |                                     | HBR                     |             |
| Acoustic Conspicuity                 |                                     | ACO                     |             |
| Visual Conspicuity                   |                                     | VCO                     |             |
| Occupant Protection                  | 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                   | 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                    |             |

[Note that this table is subject to change; it needs to be fully defined and agreed between TfL and the Test House.]





## 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 R107 (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 R107 compliant system, regardless of powertrain, including zero emission vehicles.

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

Manufacturers 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.
- 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 manufacturer shall demonstrate compliance with these requirements by providing copies of the risk assessments to LBSL.



## 4.2 Security

### 4.2.1 Protecting the driver from assault

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

The driver partition screen design must incorporate adequate provision for driver/passenger communication that is accessible to all customer groups. The means of providing such communication is at the discretion of the manufacturer and, for the avoidance of doubt, may include independent systems such as an electronic two-way communication system.

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:

- fully protect the driver from sustained physical attack from any person
- 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 shall be free from rattles during normal driving, free of any significant reflections and shall not restrict or distort driver view to passenger entrance, wing mirrors or forward exterior view.

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 between 1.0 and 1.2m/s<sup>2</sup> 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 Test & Assessment protocol for AEB (Attachment 15) and it must attain a performance score greater than zero.
- The bus manufacturer 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 interior safety part of this protocol 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 manufacturer 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 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 in the TfL Digital Speed Map.
- be tested in accordance with the procedures defined in 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 (which is reflected on the speedometer).

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

#### **4.3.3.2 Operational**

When entering a speed restricted 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 restriction 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 vehicle shall then be actively limited. This shall be termed the Restricted Operating Mode (ROM). 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 engine retardation up to the level where the brake lights would be applied are permitted.
  - The system will impose a speed restriction as soon as all conditions of ROM are met.
  - The driver should be notified of any enforced retardation of the vehicle.

When in a speed restricted 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.

When a vehicle is in ROM and either:

- exits a speed restricted 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

the system should guard/mitigate against the vehicle accelerating unexpectedly if the accelerator pedal is depressed during the transition.

When the vehicle exits a speed restricted 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 personell 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. Manufacturers 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. The vehicle must travel a distance of at least 30 metres continuously inside a speed restricted zone and be within that zone for at least 5 seconds before the conditions for imposing ROM are applied.

Once the requirements above are met, the conditions for imposing ROM must be applied within 3 seconds.



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

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

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

- Vehicle in fail safe mode (signal loss)
- Vehicle not within a speed restricted 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 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 option 1
- Preferred for option 2

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 restricted 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 may be uploaded using portable data storage or existing local wi-fi network systems. To be agreed by Original Equipment Manufacturer (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 personell. 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 Vision from vehicles: General**

All buses shall allow the driver to have sufficient vision of his or her 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.

#### 4.3.5 **Blind Spot Mirrors**

All buses shall, in addition to the mandatory fields of vision described in UN ECE 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 UN ECE 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 UN ECE Regulation 46.

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

#### 4.3.6 **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 manufacturer 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.

#### 4.3.7 Enhanced Indirect and Direct Vision

*This total 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 vision standard testing and assessment protocols (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).

All buses shall meet the minimum direct vision performance score (DVS) requirement of [85]%.

All buses shall meet the minimum overall bus vision standard performance score (BVS) requirement of [85]%.

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

#### 4.3.8 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) compliant with UNECE Regulation 46 to replace physical mirrors, at least for the class II field of vision defined by the same Regulation and the blind spot fields of vision defined by the bus vehicle specifications for blind spot mirrors (section 4.3.5).

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

- [Human-machine interface requirements to be determined based on additional studies/trial results]

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



#### 4.3.9 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 and/or;
- VRU collision warning signal and/or;
- Motion inhibit

All buses shall be assessed in accordance with the Blind Spot information, Warning and intervention (BSW) systems standard testing and assessment protocol (Attachment 24), reporting the BSW performance score for each bus model or bus model variant (as appropriate). Each bus shall achieve a score of [60]% or more

The bus manufacturer 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.

#### 4.3.10 Pedal Application Error

##### 4.3.10.1 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 foot well 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



#### **4.3.10.2 Pedal use indicator lights system**

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 located 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 UN ECE 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. UN ECE Regulation 121 takes precedence in all cases.

[define the symbol and HMI requirements] – symbol, see separate email

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  $\pm 1\%$ .

Any delay between first movement of the pedal and the lamp achieving most of its steady state output, 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 CAN bus data supplied to the system must be accurate enough to determine when the driver is pressing the accelerator pedal.

The Pedal use indicator lights shall

- operate automatically without the need for the driver to activate or deactivate the system.
- operating 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 >80% of maximum
- not illuminate at a position of  $\leq 80\%$  of maximum accelerator pedal position

Only a qualified and authorised engineer shall be able to disable the system following the procedure set out by the vehicle manufacturer. 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.

In the event of a system failure the following requirements are applicable

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.

#### **4.3.10.3 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 releases the brake pedal.

Only a qualified and authorised engineer shall be able to disable the system following the procedure set out by the vehicle manufacturer. 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 an [amber/a red] warning light on the dashboard, and the halt brake light will be sufficient for this purpose.

[define standardised halt brake red warning light]

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.

#### **4.3.10.4 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.

[Sound to be defined.]

The following requirements apply:

- The feedback system shall have a master volume control that can only be set by the bus manufacturer to prevent increasing the noise levels inside the saloon of the bus.
- The level set by the manufacturer 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 manufacturers pre-set point.

- The feedback speaker(s) should be mounted behind the drivers 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 drivers head.*

#### 4.3.11 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 concert 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 >5 mile/h 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 manufacturers 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 parkbrake, 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.



#### 4.3.12 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.

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 [/amber] warning light shall activate. System checks shall be included in the regular maintenance checks.

[define standardised halt brake red warning light]

### 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<sup>1</sup>.

All quiet running buses of categories M2 and M3 are fitted with a front emitting Acoustic Vehicle Alerting System (AVAS) which is fully compliant with UNECE Regulation 138. This include 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 anticipates adding extra requirements, above those for Regulation 138, for idling/stationary sound, night time etc, which are yet to be defined. These shall be in addition to the Regulatory requirements. Type approval is sufficient for this, not every individual bus.

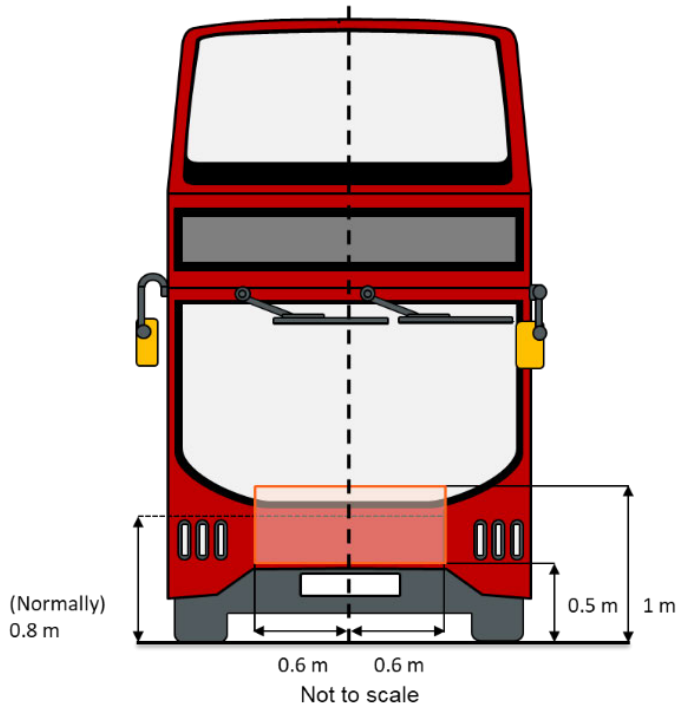
A two channel directional AVAS should be selected. *Note: Early discussions with an AVAS manufacturer revealed that two options were available. These were an ECU with integrated speaker and an ECU with separate speaker (2ch). This gives options when maximum dimensions, size and weight constraints are considered.*

A 2 channel system is preferred because it allows for the two main accident scenarios to be catered for, that being stepping off the kerb and already crossing in front of the bus. The output speakers shall be concealed at the front of the bus:

- Horizontal plane - up to a maximum 0.6 m either side of the centre line of the bus
- Vertical plane - between 0.5 m to 1.0 m (Normally 0.8 m) from the ground plane

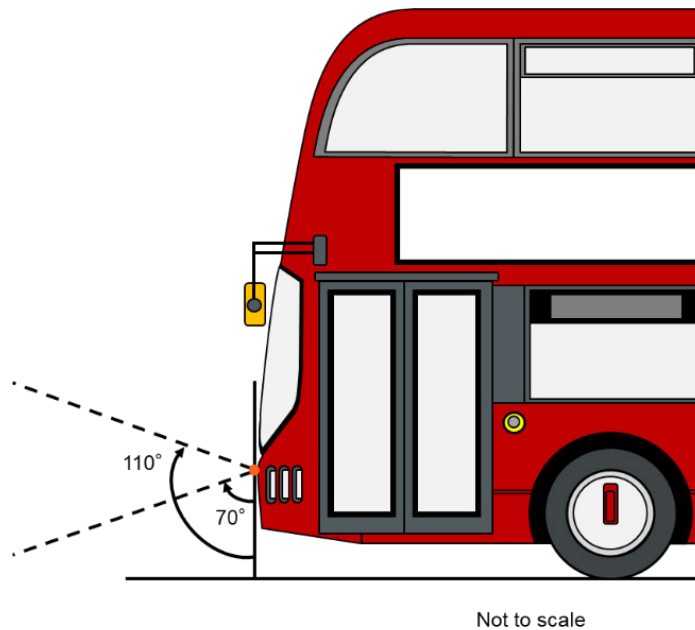
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<sup>1</sup> UN ECE Regulation 138; Uniform provisions concerning the approval of Quiet Road Transport Vehicles with regard to their reduced audibility.

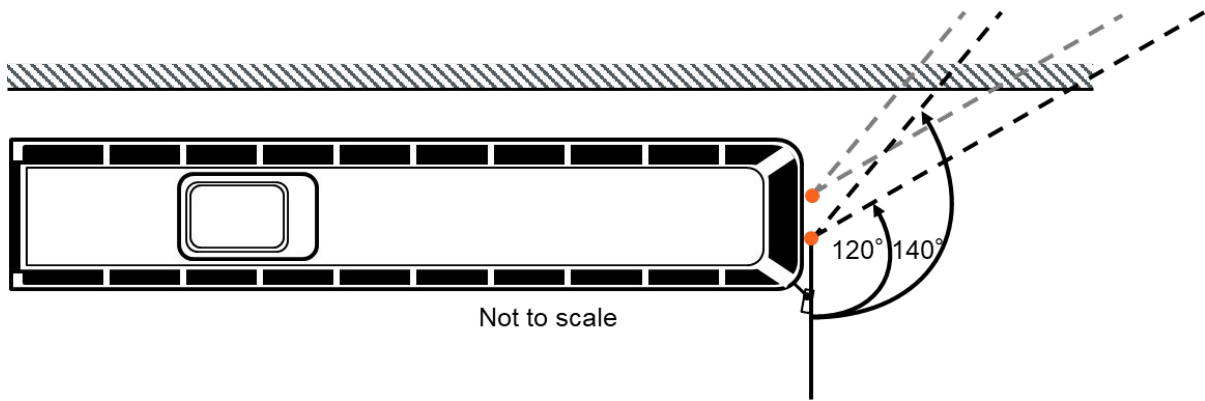


The speaker(s) must be installed such that they have an unobstructed sound path in the direction they are intended to be effective.

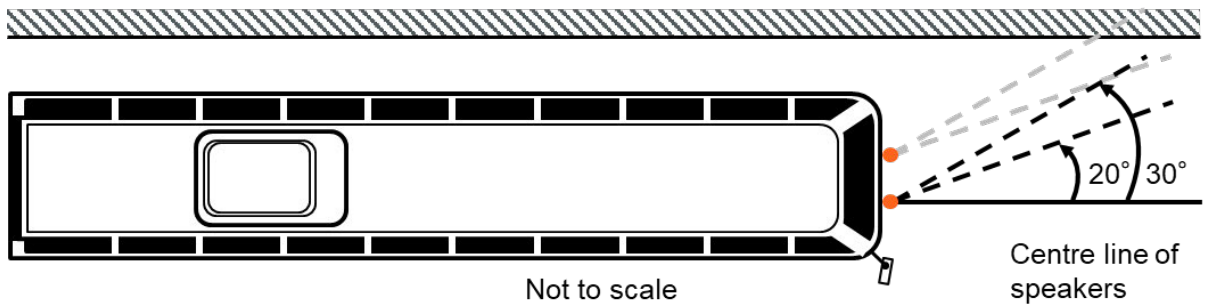
The speakers shall be positioned one on each side of the bus front. Each speaker shall have a horizontal beamwidth/directivity pattern in the range 120° to 140° and a vertical beamwidth/directivity pattern in the range 70° to 110°.







The centre line of the speakers shall be aligned towards the nearside kerb at an angle of 20° to 30° from the centre line of the bus. The speakers shall be mounted on the front surface of the bus.



If the two speakers are playing the same sound, the sounds shall be incoherent to avoid interference patterns affecting conspicuity.

The AVAS shall be capable of receiving an updated sound file in the future, e.g. as a minimum locally via USB, or optionally via telematics (mass update).

The system shall have the capability to have at least 3 sounds stored on the system (one sound at installation / entry into service, then a further two additional sounds)

The sound to be used with the AVAS for London buses is LBSL Urban bus sound, version 1.0.

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

#### 4.4.2 Visual Conspicuity

The housings for driver's near side and off side 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.

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

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

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

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

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

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

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

### 4.5.2 Seats

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

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

### 4.5.3 Handrail/stanchion construction and installation

All handrails and stanchions shall be constructed such that they 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 hand rails 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 wheel chair 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 No. 107<sup>2</sup>.

*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 passengers 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.

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<sup>2</sup> <https://www.unece.org/fileadmin/DAM/trans/doc/2015/wp29grsg/ECE-TRANS-WP29-GRSG-2015-34e.pdf>



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 all flooring material types shall be characterised under wet conditions and in all directions as per the test and assessment protocol.
- All flooring material types shall, at the point of entering service, provide a slip resistance of at least 36 (Pendulum Test Value) PTV.
- All flooring material types shall, after 100,000 passengers have accessed the vehicle, or after an in-service period of 6 months, whichever is sooner, provide a slip resistance of at least 40 PTV.
- Thereafter, all flooring material types shall, for a period of 7 years from the point of entering service, provide a slip resistance of at least 40 PTV (based on an annual assessment).

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

See also Section 4.3.10.4..

## 4.6 Partner Protection

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 manufacturer for a speed of 40 km/h).



#### 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  $[0.8]-[1.2]$  m from the ground plane and across the test vehicle width at the bus front end; 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 across the test vehicle width at the bus front end.

Horizontal angle is specified as an angle in the horizontal 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. Minimum requirements shall be:

- Minimum horizontal angle of  $[15]^\circ \pm 0.5^\circ$  tested at the worst case location between lateral positions of 0-0.3 m from the most lateral aspect of the test vehicle width at the bus front end and between vertical heights between  $[0.8]-2$  m from the ground plane; or
- Wrap around windscreen and bumper bus front end design with a radius of curvature of  $>0.3$  m tested at the worst case location between lateral positions of 0-0.3 m from the most lateral aspect of the test vehicle width at the bus front end and between vertical heights between  $[0.8]-2$  m from the ground plane.

Bus front end features and components with a cross section of less than 236 mm x 236 mm shall be exempt from these requirements.

Test vehicle width shall be defined as the distance between two points located at the most lateral aspects of the vehicle structure (see ISO 612-1978 for component exemptions) and coincident to the first axle.

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

A package of simulation evidence assessing injury risk may be submitted to TfL for consideration instead of meeting the geometric requirements. Please consult with TfL for guidance.



#### 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*

The Enhanced Geometry is defined as for the minimum geometry above except that the following requirements shall supercede their equivalents defined by the minimum geometry:

- Minimum vertical rake angle of  $[8]^\circ \pm 0.5^\circ$  tested at the worst-case location between vertical heights of  $[0.8]-2.0$  m from the ground plane and across the test vehicle width at the bus front end.
- Minimum horizontal angle of  $[15]^\circ \pm 0.5^\circ$  tested at the worst case location at lateral positions  $>0.5$  m outboard from the longitudinal centreline of the bus front end and between vertical heights of  $[0.8]-2$  m from the ground plane; and
- Minimum horizontal angle of  $[30]^\circ \pm 0.5^\circ$  tested at the worst case location between lateral positions of  $0-0.3$  m from the most lateral aspect of the test vehicle width at the bus front end and between vertical heights between  $[0.8]-2$  m from the ground plane.

#### 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 headform impact test result leading to a head injury criterion (HIC15) value in excess of  $[1,300]$ .

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 [new] bus shall have a windscreen wiper spigot:

- Lower than 2.0 m from the ground plane, and
- With a headform impact test result leading to a head injury criterion (HIC15) value in excess of [1,300].

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

#### 4.6.5 VRU Frontal Crashworthiness: 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 4.3.8.

## 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. Manufacturer / 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 engines running long periods at idle, an automatic engine shutdown system shall be incorporated. The engine 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 manufacturer 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 completed vehicle supplied for testing either by the manufacturer 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 manufacturer 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 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

Manufacturers 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 manufacturer's LBSL reference number must be quoted on all proposals. If a manufacturer 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 by 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<br>Single door<br>36 |       | Single deck<br>Single door<br>45 |       | Single deck<br>Dual door<br>50 |       | Single deck<br>Dual door<br>55 |       | Single deck<br>Dual door<br>60 |       | Single deck<br>Dual door<br>70 |       | Double deck<br>Dual door<br>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                           |       | 1840                           |       |
| Entrance Door Clear Width                                      | mm     | 1200                             |       | 1200                             |       | 1035                           |       | 1035                           |       | 1035                           |       | 1035                           |       | 1035                           |       |
| Exit door Clear Width  | mm     | n/a                              |       | n/a                              |       | 1200                           |       | 1200                           |       | 1200                           |       | 1200                           |       | 1200                           |       |
| <b>Passenger capacity:-</b>                                    |        |                                  |       |                                  |       |                                |       |                                |       |                                |       |                                |       |                                |       |
| 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



## 6.2 Energy efficiency – Electric Vehicles

Manufacturers 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.

To maximise interoperability between electric buses and charging systems, the charging interface should meet industry-recognised, open protocols – whether de-facto or published international standards. The charging interface ‘standard’ which defines the physical connection or electromagnetic coupling between vehicle and its charging system can include:

- Orientation/ alignment of the vehicle with respect to the charging connection
- Location of charging connection/ interface on the vehicle
- Communication protocols between vehicle and charging system
- Dimensional parameters/ boundaries (whether conductive via plug-and-socket or pantograph, or wireless/ induction)

## 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 Bus 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 doorways are as follows:

- Entrance and front door exit only shall provide an individual clear width of 1035mm minimum (1100mm for single door vehicles excluding door mounted handrails) and utilise an equal width two door leaf closure
- Exit doors to provide an individual clear width of 1200mm minimum (excluding door mounted handrails) and utilise an equal width two door leaf closure

## 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 manufacturer 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 manufacturers. 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 manufacturer against each tender award.

All buses must make provision for the installation and suitable protection of this equipment. The approved package of installation must consider the free issue 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.

The ticket machine base position must 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 manufacturer'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

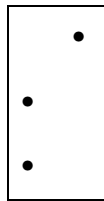


A manual or automatic security arm shall not be used to replace the floor to ceiling handrail.

*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 provided (on both decks where applicable). These shall be suitably positioned for maximum visibility to passengers. Suitable mouldings and fixings for the LBSL provided iBus signs must be provided. Duplication of this iBus signage is not permitted with LBSL's consent.

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

- Seats, 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.

An 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 be capable of operating independently from the saloon heating, upper deck cooling or cab air conditioning.

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 (ie 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 manufacturer 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 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 notices guidance booklet, 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 manufacturers 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 booklet.

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.